

Journal of STEM Teacher Education

Volume 47

Issue 3 *JSTE Winter*

Article 1

2010

Complete Issue

Follow this and additional works at: <http://ir.library.illinoisstate.edu/jste>

Recommended Citation

(2010) "Complete Issue," *Journal of STEM Teacher Education*: Vol. 47: Iss. 3, Article 1.

Available at: <http://ir.library.illinoisstate.edu/jste/vol47/iss3/1>

This Complete Issue is brought to you for free and open access by ISU ReD: Research and eData. It has been accepted for inclusion in Journal of STEM Teacher Education by an authorized administrator of ISU ReD: Research and eData. For more information, please contact ISURed@ilstu.edu.

Journal of sTEm TEACHER EDUCATION
Winter 2010 Issue Contents
Volume 47, Number 3

From the Editor 3

Articles

- | | |
|---|----|
| Comparison and Consolidation of Models of
Personal Epistemologies
by Linda Urman and Gene L. Roth | 7 |
| Exploring a Web-Based Pedagogical Model to
Enhance GIS Education
by Richard Lisichenko | 49 |
| Repositioning the Facilities in Technical College
Workshops For Efficiency: A Case Study of
North Central Nigeria
by Ibrahim Y. Umar and Abdullahi S. Ma'aji | 63 |

Bits and Pieces

Information for Authors	86
Change of Addresses and Undelivered Issues of the <i>Journal</i>	88
Request for Back Issues of the <i>Journal</i>	89
AsTEm Membership Form	90
JSTE Editors 1963 to Present	91
Association Officers	92
Institutional Members	93

FROM THE EDITOR

Change Has Been Good

As I was writing this year's status report for JITE/JSTE to be given at the ACTE December Conference in Las Vegas, I realized that there is a real need to reflect on what has happened to the journal this past year, 2010, and ponder about the future. Generally at this time the outgoing editor usually says a few words about how it has been a pleasure to work with everyone involved with the journal, and it has been, but the work is not over yet. The editorship is a two year position and my two years are over this December. As many of you already know, I am not going anywhere, at least for a while, until a new associate editor is found and is able to take over as editor. When I realized that I would not be going anywhere soon, I had mixed feelings, I felt that I had done my job and it was time to go, but as I thought about it longer I realized that the journal is in the middle a major change from JITE to JSTE and will need steady leadership to get started. Now is not the time to change editors. We have seen many changes within our organization and the journal that we need to look at and ensure that we are going in the right direction, not only for 2011 but for the future existence of the organization as well as the journal.

Reflecting on the Past

Many changes have taken place during the year 2010 and as the saying goes: the more things change the more they stay the same. Our organization has changed and broadened its

scope going from the National Association of Industrial Technology Teacher Education (NAITTE) to the Association of Science, Technology, Engineering, and Math Teacher Education (ASTEMTE). With this change JITE's last edition was volume 47-1 and JSTE began with volume 47-2. There are many reasons for the changes being made that don't think need to be addressed here, but readers can rest assured the changes are for the best and things will remain the same, JSTE will continue to be the leader in its field.

Looking towards the Future

JSTE will continue to serve its readers with quality research manuscripts dealing with technology but it will not stop there, it will also include research done in the areas of science, math and engineering. Another major change that has been implemented to increase membership in ASTEMTE is that all authors submitting manuscripts to JSTE must now be members of ASTEMTE. This is not something new as many organizations have the same requirement. As we broaden our scope in different research areas we must also expand the number of manuscript reviewers in the relevant fields. These changes are not major obstacles to overcome and I am confident that JSTE will be a success given time.

In this Issue

In this issue you will find an interesting mix of content areas and subjects. The first manuscript, *Comparison and Consolidation of Models of Personal Epistemologies* by Linda Urman and Gene L. Roth, deals with the assumptions that students and instructors have about the knowledge they have of technical education (their personal epistemologies) and the affects it has on their expectations and performance in career

and technical education classrooms and laboratories. Their conceptual research was based on three major theoretical frameworks of personal epistemology, qualitative development, quantitative belief systems, and practitioner epistemological resources. A new conceptual matrix is included that provides a roadmap for better understanding theoretical frameworks of personal epistemologies, and give career and technical educators insights for further research and implications for practice. Following this interesting manuscript is the first true science manuscript to be published in JSTE. It is written by Richard Lisichenko titled *Exploring a Web-based Pedagogical Model To Enhance GIS Education*. In this manuscript the author talks about expanding the use of GIS systems beyond the traditional users, scientists and engineers, and taking it into the global community with the help of new hardware and software systems. In addition, the continued integration and access to information systems via the internet and mobile devices has contributed to the success of GIS in society. As with other technically orientated topics of study pedagogical considerations exist that include: problem solving skills, information retention, and approaches towards learning. A pedagogical approach utilizing student generated and existing internet GIS resources may provide an effective method of addressing GIS education. The final manuscript in this volume of JSTE was written by Ibrahim Y. Umar and Abdullahi S. Ma'aji titled *Repositioning The Facilities In Technical College Workshops For Efficiency: A Case Study Of North Central Nigeria*. In this manuscript the authors talk about the need to evaluate technical colleges, using the ones in North Central Nigeria as a guide to explore better ways to make them more efficient. Two research questions were formulated to guide the study. Their finding will help improve technical colleges in North Central Nigeria and can be used by technical colleges throughout the world.

I really enjoyed reading all the different manuscripts in this issue of the journal and am sure you will also. What a great way to finish of the year and a new beginning for 2011.

Comparison And Consolidation Of Models Of Personal Epistemologies

Linda Urman
DeVry University

Gene L. Roth
Northern Illinois University

Abstract

Assumptions that students and instructors have about their personal epistemologies have important effects on their expectations and performance in career and technical classrooms and laboratories. Personal epistemologies of career and technical education students influence their behaviors in classes and their interactions with instructors. The conceptual analysis of this research was based on three major theoretical frameworks of personal epistemology: qualitative developmental stages, quantitative belief systems, and practitioner epistemological resources. Seven models of personal epistemologies were compared, and a consolidated conceptual framework is presented to career and technical educators. This new conceptual matrix is intended to provide a roadmap for better understanding theoretical frameworks of personal epistemologies, and give career and technical education educators insights for further research and implications for practice.

Linda Urman was a Senior Professor of English, DeVry University, Addison Campus, Addison, Illinois. She died July 30, 2010. Linda was dearly loved by her students, colleagues, family, and friends.

Gene L. Roth is Professor of Adult and Higher Education; Northern Illinois University, DeKalb, Illinois. He can be reached at groth@niu.edu.

Introduction

Most experienced career and technical education (CTE) instructors have occasionally experienced baffling responses from students, evidence that they were not connecting on basic assumptions about what was supposed to be happening in the instructor—learner relationship. For example, I recall leading a stimulating discussion regarding the possible meaning behind the title of a classic poem with students in a career-oriented university. Whereas I felt a sense of instructional grandeur from leading a terrific discussion, my teacher bravado came down with a resounding thud when a student asked, “So, what’s the right answer?” I replied that I didn’t know and the class broke into angry accusations. What kind of a teacher was I if I couldn’t tell them the right answer? It was my job as a teacher to explain these things properly.

In this case, and several others, I was stumped for a way to connect with the students. This puzzlement was the catalyst for this research into assumptions about knowledge -- personal epistemologies. I sought understanding of what was going on in these occasional interludes of deep confusion between instructor and learner. Different assumptions about knowledge can create varying expectations, behaviors, and goals. Recognizing and discussing these underlying assumptions might help clear up some confusion.

Personal epistemology differs from classical philosophical epistemology. Classical philosophical epistemology is one of the major areas of philosophical thought and it will not be the focus of this study. It deals with how knowledge can be obtained and justified, using formal deductions and premises to attempt to establish the extent to which we can know truth. Classical epistemology overtly questions the nature, derivation, scope, and reliability of knowledge. The ancient Greek philosophers argued about the

nature and warrants of knowledge, with logical examinations of terminology and process.

Personal epistemologies, however, are usually unexamined, tacit assumptions about the nature of knowledge and how it is acquired. Most non-philosophers have never consciously considered their assumptions about knowledge. They are unaware that they even have a personal epistemology, much less whether their assumptions about knowledge are logical or useful for the reality of their worlds. Nevertheless, these unexamined assumptions have an influence over the expectations of students, instructors, and administrators in CTE settings, as well as the opinions of policy makers and the general public.

As a starting point for this article, we need to also offer a view of knowledge. Theoretical reasoning and practical reasoning were the two categories of knowledge offered by Aristotle (Hager, 2000). Aligned with this dichotomy, Oakeshott (1962) noted that practical knowledge is uncodifiable in principle, and therefore difficult, if not impossible, to teach. It is within this realm we position knowledge for the purpose of this study – not with an emphasis on theoretical reasoning, but rather the tacit knowledge we possess but are unable to articulate (Polanyi, 1967).

For the purpose of this study, personal epistemologies refers to (and is limited to) tacit assumptions about the nature of knowledge and how it is acquired. Studying these underlying assumptions is a complex task. The literature seems to go in all directions at once, with inconsistencies in definitions, focus, and methods. The purpose of this study is to compare and consolidate seven prominent models of personal epistemologies. Given that CTE instructors and faculty members have important roles in student development (Threeton, 2007), this article is intended to help CTE

practitioners and scholars better understand the nature of personal epistemologies of students.

Method

This study relied on review and synthesis of literature as a basis for developing a new conceptual framework for personal epistemologies. Through this review and synthesis the authors were able to ascertain the extent of the research that has been done on this topic, identify common terms and constructs in the literature, and gain a historical perspective on personal epistemologies in education contexts. Literature that pertains to knowledge and epistemology is vast; however, studies specific to personal epistemologies are limited in number. Through the use of various database searches, reference lists that honed in on seminal works, and well known texts, the seven major models were selected for analysis in this study. In this article the seven models are represented as the Perry Scheme (Perry, 1970), *Women's Ways of Knowing* (Belinky et al., (1986), Epistemological Reflection Model (Baxter-Magolda, 1992), Constructive Developmental Framework (Kegan, 1980), research by the National Center for the Study of Adult Literacy (NCSAL) (Helsing et al., 2001), Reflective Judgment Model (King & Kitchener, 2002), and Epistemological World View (Schraw & Olafson, 2002). The following sections of this article present the various approaches, terms, stages, and positions portrayed by these authors. Synthesis of these models produced a consolidated framework that is offered for further testing and future research.

Three Approaches to Examining Personal Epistemologies

Although several authors are noted for their seminal work in classical philosophical epistemology (e.g., Plato, Descartes, Kant, Locke, and Russell, amongst others), the defining work associated with personal epistemology in higher education contexts is a study of how college students view knowledge (Perry, 1970). The research resulted in what was generally known as the Perry scheme, a nine position description of the intellectual and ethical development of undergraduate students. For the purposes of this literature review, researchers who focused on personal epistemology (after Perry's study) will be categorized into three groups: qualitative researchers, quantitative researchers, and practitioner researchers. The first group, qualitative researchers, continued Perry's interview methods, but with different groups of participants, different assumptions about epistemology, and different models to structure their results. These qualitative researchers, looking at different populations and focusing on different issues of epistemology, created a number of developmental models with very different formulations of the number of stages and what was contained in each stage.

Another variation of Perry's work resulted in survey instruments which could be given to large numbers of people to classify them into the perspectives of Perry's Scheme. Quantitative researchers began to challenge the idea of a general, unified epistemology. Instead of one general perspective from which students looked at knowledge, perhaps there were several independent components that developed at individual rates (Schommer, 1990). Other quantitative researchers questioned whether epistemological stance would change with the domain of that knowledge.

Finally, a third set of practitioner researchers felt that epistemology was neither a broad developmental sequence, nor a set of beliefs, but a large conglomeration of epistemological resources that are activated in specific contexts (Louca, L., Elby, A., Hammer, D., & Kagey, T., 2004). These epistemological resources appear to be the most practical strategies for CTE teachers who wish to help their students develop sophisticated views of learning and knowledge. However, not much of a research base exists yet, and issues of naming and organizing the resources, as well as the problems of generalizing from one context to another hamper the usefulness of this formulation of personal epistemology.

This literature review looks first at Perry's scheme of intellectual and ethical development in some detail, and then examines other writers who have broadened, reframed, and applied the concepts of how students, instructors, and researchers look at knowledge. The concluding section of this article includes a comparison and consolidation of the various developmental models. Hopefully this new conceptual framework will have utility for CTE practitioners and researchers, and help them better understand the personal epistemologies of learners in their respective contexts. Several qualitative studies have focused on epistemology as a form of development. Perry's work is the logical starting point for examining this strand of literature.

Perry's Scheme

Perry (1981) said that he and his colleagues, in an effort to make sense out of the baffling and contradictory student evaluations they were receiving, tried to document what "stood out" for the students as they thought about their undergraduate experiences (p.77). Perry (1970) and his colleagues were looking for forms of perception, not content, of knowledge.

How did students view their experiences, make meaning of them, and determine how to use the experiences to decide how to live their lives? The researchers constructed a series of nine positions, places from which students viewed their experiences.

The Nine Positions

Position 1: Basic Duality. Knowledge is absolute. Authorities know the answer to everything. Students can accumulate knowledge by working to memorize large quantities of right answers.

Position 2: Multiplicity Pre-legitimate. True authorities know the right answer. Confusion is assimilated into the dualistic position. True authorities use vagueness as a teaching strategy so that students will learn to find the right answer. Other opinions are from false or poorly prepared authorities. The realization that even good authorities do not know everything challenges the holders of this position (Perry, 1981).

Position 3: Multiplicity Legitimate but Subordinate. Truth is out there, but not yet discovered. Different opinions are legitimate, but temporary. The assumptions of this position are challenged by the fact that student work must be evaluated, but no absolute right answers are available.

Position 4a: Multiplicity (Diversity and Uncertainty). Where authorities do not know the answer, any opinion is as good as any other. Perry (1981) noted that this position was often labeled relativism by other commentators.

Position 4b: Relativism Subordinate. The authorities expect students to determine what authorities want, so some valid grounds for finding some opinions more valuable must exist. The transition from stage 4 to stage 5 was critically important to Perry. Perry discussed the transition in Piagetian terms, moving from *assimilation* of diverse opinions as special cases under dualism, to an *accommodation* of relativism which required the restructuring of the way meaning was framed.

Position 5: Relativism. All knowledge and value depend on context, with some special cases where dualistic right/wrong may still be appropriate. Authority itself also has to struggle with uncertainty. Students in this position 5 must still cope with the realization that their decisions and commitments are also uncertain (Perry, 1981).

Position 6: Commitment Foreseen. Decisions and commitments have to be made in order to take action, without assurance that the right one is being made. This position can be threatening and disorienting (Perry, 1981).

Positions 7-9: Evolving Commitments. A limited commitment in a specific area is made, but it does not resolve everything. The student deals with the consequences of commitment and responsibility. How can conflicting commitments be balanced? Life will be a continual cycle of decision, reevaluation, and change in an ongoing process of identity, commitment, and responsibility. Placement in these positions was very rare during the research (Perry, 1981).

Perry's Scheme was a seminal work in examining the epistemological development of undergraduate students. The idea that personal views of knowledge and learning could affect education was not new, but the research was the first to look seriously at what those views were and how students moved through them. Issues related to the very specific nature of the students in Perry's study and the worldview of the researchers, as Perry noted, made generalization problematic. However, many researchers used the Scheme as a starting point in their own investigations.

Women's Ways of Knowing

Belenky, Clinchy, Goldburger, and Tarule (1986) investigated whether Perry's scheme would work for other populations in different contexts. However, similar to Perry's work, their view was through a USA lens and did not focus on other cultures. Heavily influenced by both Perry and Gilligan (1977), they looked at the way women understand the nature of knowledge, and found results that reflected some of Gilligan's findings. Instead of Perry's nine positions, Belenky et al. described five ways that women "come to know" or experience knowledge.

Five Ways of Knowing

Silence. Individuals are totally dependent on others for self knowledge and direction. The word silence is a metaphor for having no voice of their own, being passive, and seeing themselves as incompetent. Generally associated with extreme sex-role stereotypes, in this level individuals are told what to do, never why.

Received Knowledge. At this level, individuals are able to learn information by listening to the voices of others. They see themselves as learners of absolute truth given to them by authorities. They can reproduce a copy of the knowledge given to them, but they cannot understand, evaluate, or reason about that knowledge.

Subjective Knowledge. The women at this level see their own experience and intuition as the source of knowledge. Truth is private, personal, and the opposite of absolute: multiple and infinite. Authority and traditional education have failed and are irrelevant and distrusted. The women have developed an inner voice with subjective, pragmatic knowledge, valid only for themselves.

Procedural Knowledge. At this level, women acquire and apply strategies to obtain, evaluate, and communicate knowledge. They find processes that help them form opinions and interpretations. Two types of procedural knowledge are identified: separate knowledge and connected knowledge.

Constructed Knowledge. Personal and outside knowledge, objective and subjective interpretations, rational and emotional thought are all woven together into a unique and authentic voice. Cognitive issues—*how do I learn*—are combined with moral issues—*what are my rights and responsibilities*—to form a way to deal with life in all its complexities. The learner can both talk and listen, conducting a dialogue of reciprocity and cooperation (Belenky et al., 1986).

Women's Ways of Knowing added a more diverse perspective to developmental epistemology. The general outlines of the phases are similar to Perry's, but a wider representation of gender, race, ethnicity, and socio-economic groups changed the details and the interpretations of the phases.

Epistemological Reflection Model

Baxter-Magolda (1987) initially became interested in quantifying Perry's scheme with a survey instrument she called the Measurement of Epistemological Reflection (MER). Baxter-Magolda (1992) decided to study both men and women longitudinally in an academic setting to explore gender-related differences in interpreting knowledge. Her own perspectives and assumptions shifted from a quantitative stance to a qualitative and narrative process. Baxter-Magolda (1992) referred to her new construction as the Epistemological Reflection Model. It consists of four "ways of knowing" with gender related patterns in the first three ways.

Four Ways of Knowing

Absolute. Students believe that knowledge is certain; the instructors have all the knowledge and will transmit it to them. The Receiving Pattern, more typical of females, is private, reading and listening, with little interaction. The Mastery Pattern, more typical of males, has more public interaction to demonstrate interest and secure resolution of knowledge conflicts from authority.

Transition. Students see some knowledge as uncertain. The female-associated Interpersonal Pattern actively seeks others' opinions and interaction, and looks for rapport with the instructor. The male-related Impersonal Pattern looks for challenge and debate, using logic and research.

Independent. Students see knowledge as mostly uncertain and their own opinions as valid. The female-associated Interindividual Pattern adds active engagement with others' views to their own thinking, while the male-related Individual Pattern focuses on the student's own independent thought. The emergence of Female-associated Interindividual Patterns or male-related Individual patterns from a student can be influenced by learning situations, and the degree to which the student is encouraged to connect with other learners and teachers.

Contextual. Students see all knowledge as uncertain, but are able to judge some perspectives as more valid based on specific, contextual criteria. With further research in adults out of college, Baxter-Magolda (2002) identified three phases in the contextual way of knowing: External Formulas, where external expectations were used to make decisions; In Search of Internal Authority; and Foundation, where an "internally generated belief system" was in place (p. 99).

Baxter-Magolda (1992) stressed the inclusion of the more collaborative, affective perspectives as important to both

sexes. While that perspective was somewhat more typical of females than males, it was not gender specific. Baxter-Magolda speculated that the perspective was not noticed before Belenky et al. simply because the perspective associated with males was assumed to be the norm. The assumptions and world view of the researcher, often male, was as important as the perspectives of the participants in terms of what the researcher would discover.

Baxter-Magolda also had observations about how education could support and encourage the development of students. She started her research hoping to redesign educational practices only to discover that what was needed was a complete transformation from separate to connected relations between learner and instructor, knowledge and experience. Students needed to be encouraged to construct meaning in collaboration, to relate their knowledge to their own experience, and to see themselves as capable of finding and interpreting meaning. These design practices can be found in contemporary CTE classrooms that feature authentic instruction and constructivist methods.

Constructive Developmental Framework

Kegan (1980) attempted to integrate cognitive, emotional, and behavioral factors into a more holistic framework. Kegan defined five different stages of epistemological development as a way of looking at the way personality develops as individuals try to make meaning. His stages included the complete development of the mind's ability to organize experiences from childhood through maturity. Kegan looked specifically at the relationship between what is subject and what is object. Subject refers to what we are and what defines us, and object refers to what we can look at and reflect on (1994).

The Five Stages

Independent Elements. Young children experience perceptions as immediate, unconnected, and temporary. They are aware only of their own consciousness.

Durable Category. As older children are able to examine their perceptions, they are able to see their experience as concrete and logical. They develop a self concept and an idea of their role in their social context. This stage is not appropriate for adults; in fact, Kegan considered it an explanation for sociopathic behavior (1994).

Cross-Categorical Knowing. Teen-agers or adults examine their concrete reality and create abstractions, self-reflective emotions, and social consciousness. Kegan considered this stage socialized traditionalism and felt that it worked for people who did not often encounter people from other cultures or who were not subject to fast moving changes in their environment.

System/Complex. Modernism requires that people examine their abstractions and inner states and become self-authoring individuals who can deal with multiple roles and multiple cultures.

Trans-System, Trans-Complex. Postmodernism adds further demands on individuals' ability to organize experience in the face of paradox, contradictions, and oppositeness (Kegan, 1994). Individuals must become self-transforming, able to accept the interpenetration of complex systems in themselves and others.

Kegan emphasized the process of meaning making and the emotional distress that accompanies the experience of development. He was also aware of Mezirow's theory of transformative learning, and saw its application to the crises that result in development (Kegan, 2000). However, he had some serious reservations about the privileging of Mezirow's

self-authoring mode, and the lack of emphasis on the affective response. If CTE educators focus only on cognitive development and ignore emotional reactions, they don't realize that they are asking students "to change the whole way they understand themselves, their world, and the relationship between the two. They are asking many of them to put at risk the loyalties and devotions that have made up the very foundations of their lives" (Kegan, 2000, p. 67).

One group that used Kegan's theories as the basis for their research was the National Center for the Study of Adult Literacy (NCSALL) Adult Development Research Group. Most studies have used university students, generally white, economically middle to upper class, born in the United States of America, as participants. Helsing, Drago-Severson, Kegan, Portnowe, Popp, and Broderick (2001) specifically targeted immigrants to the United States who were participating in Adult Basic Education courses. They identified three ways of knowing.

Three Ways of Knowing

Instrumental. Knowledge was seen as a commodity, and a way to solve problems and achieve concrete goals. Knowledge was dualistic, right or wrong, and came from external authority. For example, these types of CTE students would believe "the purpose of education is to get X" (Helsing, et al., 2001). They would evaluate learning based on grades and diplomas and would want CTE teachers who would insist on correct performance of tasks and skills.

Socializing. Knowledge was what one needed to know to meet social expectations and roles. Knowledge was absolute truth, passed down from the experts. "The purpose of education is to be X" (Helsing, et al., 2001). Learning was evaluated based on the learners' attitude and ability to fit into their new culture. For example, these types of CTE learners

would want CTE teachers who would care about them and acknowledge them.

Self-authoring. Knowledge was necessary for personal growth and understanding, allowing students to build a better society. Knowledge was self-constructed, from a specific context, based on individual interpretation, values, and predictions. “The purpose of education is to become X” (Helsing, et al., 2001). Education was evaluated on its usefulness in contributing toward the achievement of personally constructed goals. For example, these types of CTE learners would expect a good CTE teacher to encourage CTE students to take responsibility for their own education.

Reflective Judgment Model

King (1992) investigated the way people explain and justify their interpretations about controversial topics. Grounding her study in the cognitive developmental perspectives of Piaget and Kohlberg, King made four assumptions: (1) People actively construct meaning from their experiences, (2) ways of interpreting experience develop over time, (3) interaction with the environment causes development, and (4) people exhibit responses from several stages, depending on concentration and support.

King and Kitchener (2004) differ from Piaget’s and Kohlberg’s assumptions about stages in two ways: first, individuals do not use just one stage at a time, but normally have access to the adjacent stages in the way that they look at problems. Second, the stages do not make up “an invariant sequence that exists across all cultures” (p.10). In fact, King and Kitchener insist that the skills exhibited will depend on the conditions of the assessment.

King and Kitchener (2004) used 25 years of reflective judgment interviews, based on four controversial issues with a

series of probes to evidence assumptions about knowledge. Thousands of high school, college and graduate students, and other adults were interviewed and the transcripts scored to develop and verify the Reflective Judgment Model (Hofer & Pintrich, 1997). The model was structured around three major categories, made up of seven stages (King & Kitchener, 2002).

Three Categories, Seven Stages

Prereflective Thinking. Stage 1 -- Knowledge is concrete and absolute. Stage 2 -- Knowledge is certain, but may not yet be discovered. Stage 3 -- Where knowledge is certain, authorities are the source. In areas where knowledge is not yet available, personal beliefs are the source of judgments.

Quasi-Reflective Thinking. Stage 4 -- Knowledge is uncertain and evidence to defend knowledge claims is specific to individual whims. Stage 5 -- Knowledge is contextual. Evidence depends on the rules for a specific domain.

Reflective Thinking. Stage 6 -- Knowledge is constructed. Evidence comes from many contexts and experts. Stage 7 -- Knowledge is constructed by a process of inquiry. Evidence is whatever is currently reasonable and likely, with reevaluation when new information becomes available.

Although reflective judgment is related to critical thinking, King and Kitchener (1994) chose to emphasize Dewey's (1933) concept of reflective thinking over the logical or mathematical reasoning associated with critical thinking. Reflective thinking is necessary when formal logic will not work because of controversy or doubt about the understanding and assumptions of a given issue, or because sufficient information cannot be obtained. King and Kitchener (2004) call these issues "ill-structured problems" because "they cannot be defined with a high degree of completeness, and . . . they cannot be solved with a high degree of certainty" (p. 5).

Epistemological World Views

Defining some beliefs as naïve or as mature was an issue that Perry (1970) wrestled with and chose to deal with by explicitly explaining his underlying assumptions and values. Most of the researchers highlighted in this literature review have a similar bias toward beliefs that knowledge is complex and tentative, integrated, and constructed from interpretations of experience. Certainly not all researchers, much less all teachers, agree with this view. For example, Bull (2002) holds that teachers are being brain-washed and indoctrinated to accept the constructionist epistemology, which contradicts his moral axiology. Strangely, little research has been conducted on the epistemological beliefs of teachers, although King and Kitchener (2004) included teachers as participants in some of their studies.

Schraw and Olafson (2002) attempted to investigate teachers' epistemological world views. By synthesizing research from the disciplines of psychology, educational psychology, and education, they constructed a three category epistemological world view.

Three Categories

Realist. Knowledge is fixed, universal and unchanging. The core body of essential knowledge and skills material is transmitted, often by direct instruction, to the students who are passive recipients. Learning should be assessed through norm-referenced, reliable, objective tests.

Relativist. Knowledge is subjective, self-constructed, highly changeable and idiosyncratic to the individual. No one opinion is privileged over another. The teacher creates an environment which encourages independent thinkers through modeling, questioning, and independent projects. Assessment

is based on individual learning goals and may consist of work in various media.

Contextualist. Knowledge is situational and changeable over time, and should have authentic application to the students' needs. It is collaboratively constructed by the students with the teacher as facilitator. A transactional, group-based approach is an appropriate means of instruction. Assessment is often by local, criterion-based instruments, or portfolios or other performance based evaluations.

Schraw and Olafson (2002) interviewed 24 K – 8 teachers and had them complete questionnaires on their epistemological beliefs, their level of agreement with the world views, a Need for Cognition Scale, a Motivation for Teaching Scale, and a written statement articulating their beliefs. The researchers noted that the longer the teachers taught, the more likely they were to support a realist world view, perhaps because they were adapting to an environment which demanded it. This message should not be lost to CTE educators – the current emphasis on assessment and accountability is apt to influence their personal epistemologies over time.

Quantitative Research: Epistemology as Beliefs

Several quantitative studies have examined epistemology as beliefs about knowledge. Schommer's work is a good starting point for this strand of literature.

Epistemological Belief Systems

Schommer (1998b) became interested in epistemological beliefs because of research on the phenomenon of the illusion of learning—the belief that you know when you really do not know—did not explain why individuals had such confidence about their misunderstandings. After reviewing the

literature and noting the discrepancies between the different formulations of epistemological views, Schommer decided to attempt to synthesize the ideas, while retaining the complexity of personal beliefs about knowledge. Schommer came up with an epistemological belief system of five “more or less independent beliefs,” each of which contains a range of views.

Five Beliefs

Certain Knowledge: Stability of knowledge. Is knowledge certain and unchanging or is knowledge tentative and evolving?

Simple Knowledge: Structure of knowledge. Does knowledge consist of unrelated and isolated pieces or is knowledge made up of integrated concepts?

Omniscient Authority: Source of knowledge. Is knowledge received from authority or is knowledge derived from personal observation and reason?

Quick Learning: Speed of knowledge. Does learning occur quickly or not at all or is learning a gradual and cumulative understanding?

Innate Ability: Control of knowledge acquisition. Is the ability to learn fixed at birth or can the ability to learn improve over a lifetime? (Schommer-Aikens, 2002, p. 105).

Schommer's research indicated an association between an epistemological belief and an educational outcome: the more students believed in Simple Knowledge, the more likely they were to do poorly on the mastery test and overestimate their ability to understand material. More indirectly, they were less likely to use effective study strategies (Schommer, 1993).

Schommer and other researchers replicated these findings and modified the survey instrument (Jehng, Johnson, & Anderson, 1993; Schraw, Bendixon, & Dunkle, 2002), linking various beliefs with specific educational outcomes. A large amount of research material was generated in ten years,

which Schommer-Aikins (2002) summarized in a theoretical framework:

- Epistemological beliefs are a system, more than one belief, although there is nothing sacred about the idea of four or five beliefs. These beliefs can develop and mature at different times, giving people different levels of understanding about specific concepts.
- Epistemological beliefs have both direct and more subtle, indirect effects on learning. For example, someone who believed that knowledge was certain and unchanging would tend to see even tentative conclusions as definitive statements, a direct effect on comprehension. In a more indirect way, someone who believed that knowledge consisted of unrelated bits of information would see education as recalling lists of facts and see memorization as a good study strategy.
- Epistemological beliefs of a given individual may vary from domain specific to domain general, depending on the situation.
- Epistemological beliefs develop and change because of life experience and education.

Before Schommer, educational researchers had assumed that although epistemological views were complex combinations of assumptions, they developed together. Schommer (1998a) indicated that at least the beliefs about structure, stability, speed, and control could develop separately. Beliefs about the structure and the stability of knowledge tended to be a function of the amount of higher education received. The more college education students experienced, the more likely they were to see knowledge as complex and evolving. Beliefs about the speed and control of learning seemed to be a function of age. As participants got older, they were more likely to see learning as gradual and the ability to learn as improvable.

Hofer and Pintrich (1997) criticized Schommer for using belief statements which were not purely epistemological; that is, they were not based on the nature of knowledge. The first three of Schommer's original five statements came from Perry's scheme, but the last two, dealing with quickness and control of knowledge acquisition, were more about the nature of learning than the nature of knowledge, and followed Schoenfeld's (1983) work with mathematical beliefs and Dweck and Leggett's (1988) work on beliefs about intelligence. Schommer-Aikins (2002) explained that beliefs about learning were closely related to the view of knowledge and, practically speaking, were factors in such educational outcomes as persistence and value of education. Schommer-Aikins believed that the decision of which beliefs to include and exclude should depend on relationships between concepts, through the lens of the researcher, and the intended scope of the research.

Epistemology as Resources

A few researchers have viewed personal epistemologies as resource based. Their work is highlighted in the following section.

Framework of Epistemological Resources

Hammer and Elby (2002) did not see personal epistemologies as either a coherent developmental theory or a system of beliefs. They saw an alternate structure, a "manifold ontology" (p. 175), based on small units of cognitive structure, beliefs that change based on both domain and context. Hammer and Elby called these elements epistemological resources, and asserted that different resources were activated in different circumstances. Hammer and Elby summarized four general categories of resources.

Four Resource Categories

“Resources for understanding the nature and sources of knowledge” (p. 177). Knowledge might be seen as “propagated stuff,” information transmitted from a source to a recipient. Or knowledge might be “free creation,” or “fabricated stuff,” new inventions, or ideas synthesized from other material (p. 178).

“Resources for understanding epistemological activities” (p. 179). Explanations for answering the question “How do you know _____?” include accumulation, formation, checking, and application.

“Resources for understanding epistemological forms” (p. 180). Forms that activate different sets of resources include stories, rules, “songs, lists, pictures, categories, statements, words, names, and numbers” (pp. 180-81).

“Resources for understanding epistemological stances” (p. 181). Various stances—belief, doubt, disbelief, understanding, puzzlement, and acceptance—must be understood to react to information.

The idea that epistemological beliefs are so context related that they are not part of a system of beliefs is controversial. Baxter-Magolda (2004) agreed that these “domain specific beliefs are a part of personal epistemology,” but she did not see them as separate entities. Baxter-Magolda stated “epistemological transformation is a shift to a more complex set of epistemological assumptions rather than the acquisition of particular learning strategies or skills” (p. 31).

Personal Epistemologies – Summary of Models

Qualitative Studies

Qualitative researchers tended to end up with models of epistemological development similar to Perry’s Scheme. However, because each researcher interviewed participants

with very different demographics and issues, the research generated a number of models, with different metaphors used for explanation, and varying numbers and contents of stages (Belenky et al., 1986; Baxter-Magolda, 1992; Kegan, 1980; Helsig et al., 2001; King & Kitchener, 2002; Schraw & Olafson, 2002).

The level at which a given individual views knowledge can change over time. The qualitative researchers in this literature review characterized this change as a developmental process, leading to a contextual level that is the most mature and sophisticated (Perry, 1970; Belenky et al., 1986; Baxter-Magolda, 1992; Kegan, 1980; Helsig et al., 2001; King & Kitchener, 2002; Schraw & Olafson, 2002). Some of the researchers note that students can use more than one level (Perry, 1970; King & Kitchener, 2004); however, in general, personal epistemology is seen as a unified sequence by qualitative researchers.

Quantitative Studies

Quantitative researchers theorized independent components to epistemology instead of a general, unified concept, and developed surveys which could be given to large numbers of people. The five more-or-less independent beliefs theorized by Schommer (1994) are Certain Knowledge, Simple Knowledge, Omniscient Authority, Quick Learning, and Innate Ability. Different researchers have found results for some of these beliefs which indicate that they may develop at different times and rates (Jehng, Johnson, & Anderson, 1993; Schommer, 1994, 1998a; Schommer-Aikens, 2002; Schraw, Bendixon, & Dunkel, 2002). Most of the research concentrates on the relationship of these beliefs to educational outcomes. For example, Schommer (1990) showed that some beliefs are associated with scores on reading comprehension tests. The more that participants agreed that the speed of learning was

quick or not at all, the more likely they were to oversimplify their concluding statements, do poorly on the content test, and overestimate their understanding.

Practitioner Studies

Finally, practitioner researchers conceptualized epistemology not as a broad developmental sequence, nor as a set of independent beliefs, but as a conglomeration of resources that could be activated in specific contexts (Louca, Elby, Hammer, & Kagey, 2004). Hammer and Elby (2002, pp. 178-181) summarized four general categories of resources: (1) Resources for understanding the nature and sources of knowledge, (2) resources for understanding epistemological activities, (3) resources for understanding epistemological forms, and (4) resources for understanding epistemological stances. These resources need to be studied in the context of a specific educational experience, such as the CTE context; thus, metaphors and cues used by CTE teachers to help the students activate the resources can be examined.

Comparing and Consolidating the Epistemological Models

The various researchers who have looked at personal epistemology have done so from three different theoretical stances. First, some researchers saw personal epistemology as a view of knowledge that developed with increasing maturity and education. These researchers for the most part used interview strategies to obtain their data and constructed complex models of the developmental stages of personal epistemology. Second, some researchers asserted that personal epistemology was a system of separate beliefs about knowledge which developed more or less independently of each other. Their research used surveys of large numbers of people to correlate different beliefs with specific educational

outcomes. Finally, theorists who saw personal epistemology as sets of resources which could be activated in specific contexts used practitioner research to investigate these resources and how they could be used in specific environments. In general, these environments were classroom situations where specific topics required modification of common assumptions about knowledge. In order to attempt to synthesize the information from these different points of view, Table 1 presents a comparison and consolidation of the developmental epistemological models.

Table 1 Comparison of Epistemological Models

	Absolute	Subjective	Contextual
Perry's Scheme Perry (1970)	Position 1 – Basic Duality. Knowledge is absolute, quantitative, and known by authority. Position 2 – Multiplicity Pre-legitimate. True authorities use ambiguity to teach. False authority exists. Position 3 – Multiplicity Subordinate. Truth may not yet be discovered.	Position 4a - Multiplicity. Any opinion is as good as any other.	Position 4b – Relativism Subordinate. Some valid criteria exist. Position 5 – Relativism. All knowledge depends on context. Position 6 – Commitment Foreseen. Position 7 – Initial Commitment. Position 8 – Implications of commitment. Position 9 – Developing Commitment.

Women's Ways of Knowing Belenky et al. (1986)	Silence – Cannot learn from language. Received Knowledge Absolute truth given by authorities.	Subjective Knowledge – Personal experiences and intuition.	Procedural Knowledge – Strategies to get, evaluate, and share knowledge. Separate knowledge – The doubting game. Connected knowledge – The believing game. Constructed Knowledge - Personal & external knowledge, rational & emotional thought, and interwoven.
Epistemological Reflection Model Baxter-Magolda (1992)	Absolute-Certain – Knowledge transmitted by authority. Receiving Pattern – private reading and listening. Master Pattern – public interaction. Transition – some knowledge seen as uncertain.	Independent – Personal opinions are valid.	Contextual – All knowledge is uncertain, but some perspectives are more valid, based on contextual criteria.
Constructive Development Framework Kegan (1980)	Independent Elements – unconnected perceptions. Durable Category - Self-concept & social roles. Cross-Categorical Knowing – Socialized traditionalism.		System/Complex – Self-authoring, multiple cultures. Trans-System/Trans-Complex – Self-Transforming.
NCSAL Helsig et al. (2001)	Instrumental – Knowledge is a commodity from		Self-Authoring – Knowledge is self-constructed,

	authority “To get X” Socializing – Knowledge is absolute truth from experts “To be X”		contextual, “To become X”
Reflective Judgment Model King and Kitchener (2002)	Stage 1 - Knowledge is concrete and absolute. Stage 2 - Knowledge is certain, but may not yet be discovered. Stage 3 - Authorities are the source of certain knowledge; personal opinions if not yet discovered.	Stage 4 - Individual opinions defend claims to knowledge.	Stage 5 – Knowledge is contextual-specific domain. Stage 6 - Knowledge is constructed from many contexts. Stage 7 - Knowledge is constructed from inquiry and continually reevaluated.
Epistemological World View Schraw and Olafson (2002)	Realist – Knowledge is fixed, universal, and unchanging, transmitted by experts, evaluated by standardized tests.	Relativist – Knowledge is subjective and idiosyncratic	Contextualist – Knowledge is situational and changeable, constructed collaboratively, and evaluated by local, criterion-based instruments.

The seven developmental models that were reviewed in this article can be collapsed into a three level structure. The terminology used to refer to these levels has been modified to avoid the confusion engendered by the use of similar terms to refer to different stages. For the purposes of this comparison, the *Absolute* level refers to the concept of knowledge as absolute truth, transmitted by authority. The *Subjective* level indicates the assumption that knowledge is based on individual opinion and that all opinions are equally valid. Finally, the *Contextual* level represents the idea that knowledge is

uncertain and temporary, but can be evaluated by context-bound criteria.

Developmental Stages

The developmental states of the consolidated model are described in the following sections.

Absolute Level of Table 1

Perry Scheme. In discussing his nine-stage scheme, Perry (1970) noted that two dramatic shifts in the framing of knowledge occurred as the multiplistic undergraduate educational environment collided with the students' assumptions of truth as absolute and known to authority. These two shifts consisted of, first, the realization that knowledge is uncertain, and, second, the acceptance of contextual criteria to evaluate different perspectives. The first shift occurred when the discrepancies between assumptions and experience became too great, and the students' frames of references cracked under the strain. Perry saw this first shift as vitally important: "We think this is the most crucial moment in higher education" (1970, p. 37). Prior to this first crisis point, students in positions 1, 2, and 3 in Perry's scheme saw knowledge as concrete truth from authority, although with increasing amounts of difficulty as they attempted to resolve the conflict between their assumptions and their exposure to other points of view. Because the students in these three positions continued to try to assimilate their experiences into their perspective of knowledge as absolute and transmitted by authority, they fit in the Absolute level of Table 1.

Women's Ways of Knowing. Belenky et al. (1986) used the Perry scheme for the basis of their research on the ways that women view knowledge; therefore, similarities between the models are apparent. Although the metaphors changed

from visual perspective to oral speech, the initial assumptions are aligned. In both Silence and Received Knowledge, certain truth comes from outside authorities. Women who are silenced have no voice, but those who have received knowledge can reflect and follow that truth. The best fit for these two ways of knowing is the Absolute level of Table 1.

Epistemological Reflection Model. Baxter-Magolda (1992) also used the Perry scheme as the starting point for longitudinal studies of male and female college students. The Absolute way of knowing depicts knowledge as certain and unchanging, communicated from authority. The Transition way of knowing views some knowledge as uncertain, but only in special cases. The general view of knowledge is still fixed and certain, as in Perry's stages 2 and 3, in which the student is still able to assimilate gaps in certainty. Both fit into the Absolute level of Table 1.

Constructive Developmental Framework. Kegan's (1980) Constructive Developmental Framework was based not on the Perry scheme, but on clinical psychology and the relationship of the mind to its surroundings. Kegan was also looking at the whole range of development, starting from childhood, not just that of college students and adults. For these reasons, Kegan's model is very different and does not fit into the three part comparison in Table 1 as neatly as the theories above. For Kegan (2000), knowledge is formed as meaning that is shaped out of the interaction of one's inner and outer experience.

Kegan's first stage, Independent Elements, is characteristic of young children who are only aware of their own immediate inner perceptions. This stage does not have enough permanence to constitute knowledge, but what is experienced is seen as the only reality that exists. Because there is only the possibility of one reality, this stage seems to fit best in the Absolute level of Table 1. Because neither the

concept of knowledge nor the idea of authority has yet emerged, this stage could arguably be considered as a precursor to epistemological thought and not appropriate for inclusion into the three levels of Table 1. The stage does have the advantage of completing Kegan's analysis to the very beginnings of experience.

The second stage, Durable Category, reflects children who have a sense of themselves and their social roles. Their experience is concrete and logical, but does not consider the needs or consciousness of others. Because of the concrete assumptions about social interactions, it fits in the Absolute level of Table 1. However, this knowledge comes from the interaction with the social environment, but it is based on individual interpretations of what is appropriate. Because the concept of knowledge as temporary and multiple does not exist, this stage is not the same as the Subjective level of Table 1, even though it is based on personal perceptions. The personal assumptions about knowledge are as fixed and immutable as the concepts transmitted by authority in the Perry-based structures, so stage two is not a transition into the free-wheeling, anything-goes Subjective level, but stays in the Absolute level of Table 1. The most important factor for inclusion into the Absolute level of Table 1 is the concept of knowledge as certain and unchanging. The source of that knowledge changes somewhat with the different theoretical perspectives of the developmental researchers.

Stage three, Cross-Categorical Knowing, is more typical of adolescents or adults who have developed the ability for abstractions, self-reflection, and social awareness. Kegan considered the knowledge of this level to be socialized traditionalism. It is unchanging and handed down by the cultural authorities. As long as the knowledge of this stage is not challenged by other cultures or rapid changes in society, it

works quite well for people. It clearly reflects the characteristics of the Absolute level of Table 1.

National Center for the Study of Adult Literacy (NCSAL). Using Kegan's theories as the basis of their research, and focusing on immigrants taking adult basic education classes, NCSAL formulated a model of three ways of knowing (Helsing et al. 2001). In the Instrumental way of knowing, knowledge is a commodity useful for obtaining desired goals. Knowledge is concrete, absolute, and transmitted by external authority. In the Socializing way of knowing, the goal becomes the meeting of social roles and expectations, but knowledge remains absolute truth from the social authorities. Both of these ways fit well in the Absolute level of Table 1.

Reflective Judgment Model. King and Kitchener (2004) based their research on the cognitive development theories of Piaget and Kohlberg, who also influenced Perry. However, King and Kitchener focused on Dewey's (1933) idea of reflective thinking, which emphasized the issues of solving complicated problems with no clear cut solution. Their three-category, seven-stage model has a different emphasis than the Perry scheme, but it fits reasonably well into the comparison table. The first category, Prereflective Thinking, consists of three stages. In stage 1, knowledge is considered to be concrete and absolute. Stage 2 corresponds to Perry's position 3: some knowledge may not yet be discovered, but upon discovery, the knowledge will be certain. Stage 3 has some elements of the Subjective level, since in areas where knowledge is not yet discovered, personal opinion is an acceptable source of knowledge. However, since stage 3 also holds that authority is the source of knowledge that has been discovered, and that authority will eventually reveal certain knowledge with further study, stage 3 belongs in the Absolute level of Table 1.

Epistemological World View. Focusing on the epistemological views of teachers, rather than students, Schraw and Olafson's (2002) Realist category describes knowledge as fixed, universal, and unchanging; known to the teachers as authority; and transmitted by them to the students. It fits in the Absolute level of Table 1.

Subjective Level of Table 1

Perry Scheme. In Perry's scheme, when the first crisis is reached and knowledge can no longer be seen as certain and absolute, the reaction from the students can vary. Some students choose to retreat to an earlier stage, but most move from position 3 to either position 4a or 4b. Position 4a, called Multiplicity by Perry, is the basis for the Subjective level of the Comparison of Epistemological Models, Table 1. Students in this position, according to Perry, see that unchanging truth cannot be found, and they make the assumption that no basis exists to prefer one perspective or opinion over any other. Position 4b is the beginning of the Contextual level of the comparison and will be discussed below.

Women's Ways of Knowing. The Subjective knowledge of Belenky et al. (1986) belongs to the Subjective level of Table 1. Truth comes from inside, from experience and intuition. Truth is multifaceted, but is only valid for the individual who owns that particular truth.

Epistemological Reflection Model. Baxter-Magolda's (1992) Independent way of knowing assumes that knowledge is uncertain, but sees personal opinions as valid for the holder of those opinions. It reflects the Subjective level of Table 1.

Constructive Developmental Framework/NASCAL. Neither Kegan's (1980) Constructive Developmental Framework nor the NASCAL (Helsing et al. 2001) study of recent immigrants in basic adult education classes contained developmental stages that were consistent with the Subjective

level of Table 1. Several reasons are possible for the lack of a Subjective level. First, Kegan came from a different theoretical stance than Perry, looking at the interaction of inner and outer realities rather than the developmental perspectives of educational theories. Second, Perry came to believe that students took two different routes to get to the idea of contextual criteria. Some went from the Absolute stance of the first three positions to 4a, a Subjective stance. Others went directly from Absolute to 4b, a Contextual stance. Not all of the students in Perry's study had a Subjective stance toward knowledge. Finally, the Comparison of Developmental Models (Table 1) emphasizes questions concerning the structure of knowledge and the appropriate means to evaluate that knowledge. Kegan's theoretical stance and research strategies look at different factors in his developmental stages. A different set of criteria in the comparison would give a very different picture of the interrelationships of the models.

Reflective Judgment Model. In King and Kitchener's (2002) stage 4, knowledge is seen as uncertain, and individual opinion is seen as sufficient evidence to defend a claim. The stage fits well into the Subjective level of Table 1.

Epistemological World View. According to Schraw and Olafson (2002), teachers who are Relativists see knowledge as self-constructed and highly individualistic, with no opinion considered more valuable than another. Relativists are clearly in the Subjective level of Table 1.

Contextual Level of Table 1

Perry Scheme. The second shift in personal epistemology, according to Perry (1970), comes when the students who can no longer assimilate the discrepancies in expert views under the assumptions of Absolute level, learn to accommodate the new perception that conditional truth can be evaluated by temporary criteria. Instead of the chartless

confusion of position 4a, the Subjective level, where no opinion is better than any other, position 4b establishes the beginning of the Contextual level. Students in position 4b can see that in certain situations, temporary judgments can be made using contextual criteria to evaluate some perspectives as more useful, more congruent, or effective. Positions 5 through 9 indicate a continuing evolution of commitment to defensible, but uncertain claims.

Women's Ways of Knowing. Procedural knowledge and Constructed knowledge, from Belenky et al. (1986) are part of the Contextual level of Table 1. Procedural knowledge can be created, evaluated and discussed. Procedural knowledge is created and grounded in personal experience, but is not limited to the individual. It can be shared, discussed, and, most importantly, evaluated. Even though the judgments are temporary, the fact that criteria exist makes Procedural knowledge part of the Contextual level. Constructed knowledge is a deliberate combination of individual and outside knowledge. Components of logic and emotion blend together in unique ways, and discussion and cooperation are possible. The possibility of finding more effective ways of dealing with the complexities of life places Constructed knowledge in the Contextual level of Table 1.

Epistemological Reflection Model. Baxter-Magolda's (1992) Contextual way of knowing finds knowledge uncertain, but uses temporary, situational criteria to evaluate that knowledge. It fits well in the Contextual level of Table 1.

Constructive Developmental Framework. Stage four, System/Complex, of Kegan's (1980) Constructive Developmental Framework, requires individuals to be self authoring, to be able to come to terms with the multiple cultures, multiple roles, and quickly changing realities of modern life. People in this stage have given up the idea of unchanging and certain truth, but they do not insist that only

their own experience and perceptions are valid. They have moved into a stage that is consistent with Perry's position 4b, where some criteria exist for choosing between the alternate truths presented by the complex environments of modern life. The fifth stage, Trans-System, Trans-Complex pushes the multiple environments even further, to paradox and confusion. To survive the contradictions of our post-modern cultures, individuals must be self-transforming, and create necessary knowledge. Both of these stages fit the Contextual level of Table 1.

NASCAL. NASCAL's third way of knowing, Self-Authoring, depicts knowledge as constructed for specific situations by individual interpretations. Knowledge is still useful for achieving an individual's goals, but the individual decides what is valuable. The constructed knowledge is evaluated based on its effectiveness, so the Self-Authoring way of knowing fits in the Contextual level of Table 1 (Helsing et al., 2001).

Reflective Judgment Model. In stage 5, King and Kitchener (2002) discuss knowledge as contextual, with the rules for evidence specific to a given domain. Although stage 5 is part of the Quasi-Reflective stage with stage 4, the recognition of situational criteria moves it into the Contextual level of Table 1. The final category of Reflective Thinking contains two stages which belong to the contextual level. Stage 6 views knowledge as constructed from many points of view. In stage 7, knowledge is constructed from inquiry and continually reevaluated.

Epistemological World View. According to Schraw and Olafson (2002), teachers who are Contextualists view knowledge as temporary, specific to a given situation, and constructed collaboratively. The knowledge can be evaluated by criteria which depend on the context of the situation. This view belongs in the Contextual level of Table 1.

Discussion and Implications for Research and Practice

Research into student, teacher, and administrator beliefs about the nature of knowledge is important because of the pervasive influence that those beliefs have over attitude, motivation, and behavior. Career and technical education students may completely misinterpret their instructors' actions and motivations if they are operating from different assumptions about the nature of knowledge (Perry, 1970). Career and technical educators may not understand the assumptions about knowledge that guide their students. Seeking this kind of understanding can help CTE educators avoid mistakenly perceiving a student to be resistant, passive, intellectually lazy, or illogical (Belenky & Stanton, 2000). Administrators and politicians with different assumptions about the nature of knowledge may find themselves at cross purposes with teacher training and educational research (Schraw & Olafson, 2002). Exploring the personal epistemologies of each of these stakeholders is important, but difficult. The issue is complicated by the fact that the epistemological views of the researchers themselves tend to affect what strategies are used, what is noticed, and how it is interpreted. Each of the methods currently used has strengths and limitations in the exploration of personal epistemologies.

The large number of models to explain epistemological views reflects the different definitions, interests, and purposes of the researchers. Different populations of participants provide different sets of material for interpretation. The overarching beliefs held by society in general and the political regulators in particular are part of the social context in which epistemological views are negotiated. Although each of the models discussed provides rich, complex, and interesting

perspectives into the personal epistemologies of the researcher and the respective participants, each model is limited by the views of its developer and the characteristics of the group it represents. None of these models can be considered definitive for humanity in general. The intent of this article is to offer a consolidated model that may have greater utility for CTE practitioners and scholars. Future research is encouraged to test this new consolidated model and to offer viewpoints regarding its relevance for CTE contexts.

Future research that attempts to examine CTE students' assumptions about knowledge and learning, their personal epistemologies, will not be an easy task. Most people do not consciously examine their beliefs about knowledge; therefore, their assumptions remain unarticulated and difficult to define. However, these tacit beliefs appear to influence students' expectations, focus, and behavior. Measuring tacit assumptions will be tricky, particularly when the very act of investigating those assumptions brings them to light. The process of surfacing one's assumptions can cause people to reconsider or change them. Nonetheless, this research has been provided as a stepping stone for future studies that can explore personal epistemologies of CTE learners in specific contexts. We hope this comparison and consolidation of existing models of personal epistemologies provides a useful conceptual framework for CTE research and practice.

References

- Baxter-Magolda, M. (1987). A comparison of open-ended interview and standardized instrument measures of intellectual development on the Perry scheme. *Journal of College Student Personnel*, 28, 443-448.

- Baxter-Magolda, M. (1992). *Knowing and reasoning in college: Gender-related patterns in students' intellectual development*. San Francisco: Jossey-Bass.
- Baxter-Magolda, M. (2002). Epistemological reflection: The evolution of epistemological assumptions from age 18 to 30. In B. K. Hofer & P. R. Pintrich (Eds.) *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 89-102). Mahwah, N. J.: Lawrence Erlbaum Associates.
- Baxter-Magolda, M. (2004). Evolution of a constructivist conceptualization of epistemological reflection. *Educational Psychologist*, 39(1), 31-42.
- Belenky, M. F., Clinchy, B. M., Goldberger, N. R., & Tarule, J. M. (1986). *Women's ways of knowing: The development of self, voice, and mind*. New York: Basic Books.
- Belenky, M. F., & Stanton, A. V. (2000). Inequality, development, and connected knowing. In J. Mezirow (Ed.) *Learning as transformation: Critical perspectives on a theory in progress* (pp. 71-102). San Francisco: Jossey-Bass.
- Bull, B. F. (2002, Winter). Constructionist crap in Christian colleges: The indoctrination of teacher education. *The Educational Forum*, 66, 162-164. Retrieved on July 10, 2003, from WilsonSelectPlus, <http://newfirstsearch.Oclc.org/WebZ/FSPage?pagename=tempftascii:pagetype=print:entityp...>
- Dewey, J. (1933). *How we think: A restatement of the relations of reflective thinking to the educational process*. Lexington, MA: Heath.
- Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychology Review* 95, 256-273.

- Gilligan, C. (1977). In a different voice: Women's conception of self and morality. *Harvard Educational Review*, 47, 76-116.
- Gilligan, C. (1982). *In a different voice: Psychological theory and women's development*. Cambridge: Harvard U. P.
- Hager, P. (2000). Know-how and workplace practical judgement. *Journal of Philosophy of Education*, 34(2), 281-296.
- Hammer, D., & Elby, A. (2002). On the form of a personal epistemology. In B. Hofer & P. Pintrich (Eds.) *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 169-190). Mahwah NJ: Lawrence Erlbaum Associates.
- Helsing, D., Drago-Severson, E., Kegan, R., Portnowe, K., Popp, N., & Broderick, M. (2001, October). Three different types of changes. *Focus on Basics*, 5. Retrieved September 26, 2002, from <http://gseweb.harvard.edu/~ncsall/fob/2001/adult3.html>
- Hofer, B. K., & Pintrich, P. R. (1997, Spring). The development of epistemological theories: Beliefs about knowledge and knowing and their relation to learning. *Review of Educational Research*, 6, 88-140. Retrieved on July 8, 2003, from <Http://newfirstsearch.oclc.org/WebZ/FSPage?pagenam e=tempftascii:pagetype=print:entityp...>
- Jehng, J. J., Johnson, S. D., & Anderson, R. C. (1993). Schooling and student's epistemological beliefs about learning. *Contemporary Educational Psychology*, 18, 23-35.

- Kegan, R. (1980). Making meaning: The constructive-developmental approach to persons and practice. *Personnel and Guidance Journal*, 58, 373-381. Retrieved on July 17, 2003 from http://web18.epnet.com/delivery.asp?tb=0&_ua=shn+1+F5EF&_ug=1n+en-us+sid+E0AE4. . .
- Kegan, R. (1994). *In over our heads: The mental demands of modern life*. Cambridge, MA: Harvard University Press.
- Kegan, R. (2000). What forms transform? A constructive-developmental approach to transformational learning. In J. Mezirow (Ed.) *Learning as transformation: Critical perspectives on a theory in progress* (pp. 35-69). San Francisco: Jossey-Bass.
- King, P. (1992). How do we know? Why do we believe? *Liberal Education*, 78. Retrieved on July 17, 2003, from EBSCOhost, [http://web18.epnet.com/delivery.asp?tb=1&_ua=shn+4+C231&_ug=db+0%2C3%2c\\$+In](http://web18.epnet.com/delivery.asp?tb=1&_ua=shn+4+C231&_ug=db+0%2C3%2c$+In). . .
- King, P., & Kitchener, K. (1994). *Developing reflective judgment: Understanding and promoting intellectual growth and critical thinking in adolescents and adults*. San Francisco: Jossey-Bass.
- King, P., & Kitchener, K. (2002). The reflective judgment model: Twenty years of research on epistemic cognition. In B. Hofer & P. Pintrich (Eds.) *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 17-61). Mahwah, N. J.: Lawrence Erlbaum Associates.
- King, P., & Kitchener, K. (2004). Reflective judgment: Theory and research on the development of epistemic assumptions through adulthood. *Educational Psychologist*, 39(1), 5-18.

- Kohlberg, L. (1973). Continuities in childhood and adult moral development. In P. Baltes & K. Schaie (Eds.) *Life-span developmental psychology: Personality and socialization*. Orlando: Academic Press.
- Louca, L., Elby, A., Hammer, D., & Kagey, T. (2004). Epistemological resources: Applying a new epistemological framework to science instruction. *Educational Psychologist*, 39(1), 57-68.
- Perry, W. G. (1970). *Forms of intellectual and ethical development in the college years: A scheme*. Fort Worth: Harcourt, Brace, & Jovanovich.
- Perry, W. G. (1981). Cognition and ethical growth: The making of meaning. In A. W. Chickering (Ed.) *The modern American college* (pp. 76-116). San Francisco: Jossey-Bass.
- Polanyi, M. (1967). *The tacit dimension*. London: Routledge and Kegan Paul.
- Schommer, M. (1990). Effects of beliefs about the nature of knowledge on comprehension. *Journal of Educational Psychology*, 82, 498-504.
- Schommer, M. (1993). Comparisons of beliefs about the nature of knowledge and learning among postsecondary students. *Research in Higher Education*, 34, pp. 355-370. Retrieved May 19, 2005, from <http://80-wos17.isiknowledge.com.proxy2.library.uiuc.edu/CIW.cgi>
- Schommer, M. (1998a). The influence of age and education on epistemological beliefs. *British Journal of Educational Psychology*, 68, pp. 551-562. Retrieved May 19, 2005 from [Http://80-wos17.isiknowledge.com.proxy2.library.uiuc.edu/CIW.cgi](http://80-wos17.isiknowledge.com.proxy2.library.uiuc.edu/CIW.cgi)

- Schommer, M. (1998b). The role of adults' beliefs about knowledge in school, work, and everyday life. In M. C. Smith & T. Pourchot (Eds.) *Adult learning and development: Perspectives from educational psychology* (pp. 127-143). Mahwah, N. J.: Lawrence Erlbaum Associates.
- Schommer-Aikins, M. (2002). An evolving theoretical framework for an epistemological belief system. In B. Hofer & P. Pintrich (Eds.) *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 103-118). Mahwah, N. J.: Lawrence Erlbaum Associates.
- Schraw, G., Bendixon, L., & Dunkel, M. (2002). Development and validation of the Epistemic Belief Inventory. In B. Hofer & P. Pintrich (Eds.) *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 261-75). Mahwah, N. J.: Lawrence Erlbaum Associates.
- Schraw, G., & Olafson, L. (2002). Epistemological world views: A concept that is useful beyond the classroom. *Issues in Education*, 8. Retrieved July 15, 2003, from EBSCO.host,
http://web9.epnet.com/delivery.asp?tb=1&_ug=db+0%2C3%2c4+In+en-us+sid+25D22D...
- Shoenfeld, A. H. (1983). Beyond the purely cognitive: Belief systems, social cognitions, and metacognitions as driving forces in intellectual performance. *Cognitive Science*, 7, 329-363.
- Threeton, M.D. (2007). The Carl D. Perkins career and technical education act of 2006 and the roles and responsibilities of CTE teachers and faculty members. *Journal of Industrial Teacher Education*, 44(1), 66-82.

Exploring a Web-Based Pedagogical Model To Enhance GIS Education

Richard Lisichenko, Ph.D.
Fort Hays State University

Introduction

Geographic Information Systems (GIS) are defined as: “An integrated collection of computer software and data used to view and manage information about geographic places, analyze spatial relationships, and model spatial processes.” (Wade & Sommer, 2006) Originally, GIS users were comprised primarily of scientists and engineers. In time, hardware and software advancements provided the catalyst for expanded use by the global community. In addition, the continued integration and access to information systems via the Internet and mobile devices has contributed to the success of GIS in society. Aside from commercial training, institutions of higher learning have played a major role in the technical training of GIS professionals. As with other technically orientated topics of study, pedagogical considerations exist that include: problem solving skills, information retention, and approaches towards learning. A pedagogical approach utilizing student generated and existing Internet GIS resources may provide an effective method of addressing GIS education.

Richard Lisichenko is an Associate Professor at Fort Hays State University, Hays, KS. He can be reached at rlisiche@fhsu.edu.

GIS Described

GIS shares many qualities of other information systems. Data storage, data retrieval, and data display are characteristics shared by almost all. However, GIS is unique in that geographic location provides its foundation. All data that is functional in a GIS has geographic reference. There are many coordinate systems to choose from, ranging from the classical geographic latitude and longitude, to Cartesian systems such as Universal Transversal Mercator (UTM).

The second principle of GIS is the layering of geographic data. This entails categorizing similar features on the landscape into a slice of information that represents those features for a designated area. A good comparison would be a standard road map for a state: Even though there are many things the map could represent, the roads are the features of importance. Also, the state would be the designated area. In the GIS, a method called layering provides a logical and orderly method of storing relevant geographic data for display in a map-like manner and analysis.

Thirdly, GIS feature data is connected to attribute information describing it. The relationship between a feature and its attribute information provides an environment providing the graphical component of GIS to be enhanced with descriptive information. An example of this would be a layer depicting parcel information for a community. The layer would look like a typical parcel map. By selecting an individual parcel, the system would display attribute information such as: ownership, area, zone and tax information.

Although a GIS provides the means of creating quality cartographic maps, along with map elements such as titles, legends, north arrows, etc., the real power behind the information system is the ability to perform attribute and

spatial queries. The combination of geographical reference, layering, and attribute data provides the environment needed to identify specific landscape features and spatially compare them with other objects in space. Relationships between features include: distance, direction, and physical descriptions. Spatial analysis ranges from simple queries, to complex modeling.

Environmental Systems Research Institute Software

The primary provider of GIS software in the world is Environmental Systems Research Institute (ESRI). Since the 1960's, ESRI has created GIS software to accommodate a variety of client needs. Operational environments range from command line driven to windows based applications. In addition, ESRI is a leader in providing Internet GIS software solutions globally.

Released in the year 1999, ArcGIS was developed to provide an environment that was user-friendly but capable of providing robust GIS operations. The base version of this software is designated as: ArcGIS ArcView, and the higher level version: ArcGIS ArcInfo. Extension applications may also be added to enhance GIS capabilities.

The interface environment is very similar to many windows based software applications, such as menus buttons, and display windows. Aside from containing GIS operations, the most noticeable difference is how it manages and represents layers of information in a map-like manner.

Basic GIS Skills

There are several foundation GIS skills: data entry, data creation, data editing, attribute analysis, spatial analysis, and output display. Although the levels of complexity vary, almost all GIS operations fall under one of the mentioned

categories. Data types primarily comprise vector (point based models), raster (grid based models), or attribute (tabular) information (Davis, 2001). Data creation often entails digitizing paper maps or related spatial graphics into GIS format (Longley, Goodchild, Maguire & Rhind, 2007), but conversion of existing GIS data into another format and the encoding of attribute tabular data also apply. Data editing comes in many forms. These include: correcting digitization errors, updating attribute information, and adjusting coordinate information. For quality control, the Spatial Data Transfer Standard (SDTS) provides structure regarding descriptive information for the accuracy and quality of GIS data (Obermeyer & Pinto, 2008). Attributer queries access the attribute tables of GIS data to identify feature data that meet specific criteria (Ormsby, Napoleon, Burke, Groessl & Bowden, 2009). This method uses alphanumeric statements that range from finding an object by name, to identifying areas that meet complex environmental conditions. Spatial queries are those that spatially analyze the relationships between objects in space (Longley, Goodchild, Maguire & Rhind, 2007). As with attribute analysis, the level of complexity varies. An example of the simplest of spatial analysis technique is overlay analysis: determining what objects occupy the same space. An example of more complex analysis includes epidemiological modeling (Longely & Batty, 1996). Output display for GIS is typically a map that is either for reference or thematic. GIS software is capable of including cartographic elements, such as a title, legend, scale bar, as well as other operations that allow for the creation of a professional product. In addition, GIS data output can be represented in graph or tabular format (Ormsby, Napoleon, Burke, Groessl & Bowden, 2009).

Online Resources and Instruction

There is an extensive body of research regarding the potential benefits of incorporating Internet based resources towards improving education. Although research directly related to GIS education and the Internet is limited, it is logical to assume the body of Internet based resource literature can be extended to GIS education.

There are a variety of opinions regarding the effectiveness of introduction of web-based resources into, or in some cases replacing, traditional classroom approaches. The scope of Internet integration ranges from complete utilization of the Internet, to the use of web-based resources to enhance delivery. Some research suggests there is no significant difference in teaching a course online or in the classroom (Donavant, 2009). However, the proper integration of web-based resources may enhance a previously traditional class to the point that its virtual version is relatively the same in quality (Schoech, 2000). Aside from distance learning courses, a significant amount of research supports the integration of web-based resources to enhance a student's educational experience.

There are a variety of successful instances of utilizing models or frameworks. A major concept in web-based pedagogy is Just-in-Time (JIT) education. This deals with providing web-based education that can be accessed by students at any given time or place. A study by Cho, Schmelzer, and McMahon (2002) compared JIT and traditional methods. A model based on JIT, collaborative learning, critical thinking, and user acceptance of technology was generated, and results indicated potential improvements in course effectiveness. Chappell and Schermerhorn (1999) researched the impact of student electronic portfolios from the stakeholders perspective. Findings of the study indicate that aside from the standard benefits of using electronic portfolios,

university administration, faculty, students, employers, and parents/alumni demonstrated a notable level of enthusiasm and support.

A potential benefit provided by the Internet is greater communication and interaction. Persell (2004) incorporated web-based discussions in a manner that effectively enhanced student engagement in a sociology course. Kuechler (1999) explored the Internet's easily accessible data environment and noted great potential benefits. Stocks and Freddolino (2000) identified that students who provided greater access to web-based resources (discussion questions, instant feedback, self-tests) tended to rate their classroom experience higher than others. Aside from the more traditional objectives of integrating web-based resources in a classroom setting, researchers even managed to increase student knowledge and positive attitudes toward organ donation (Vinokur, Merion, Couper, Jones & Dong, 2006).

Simply using web-based resources does not guarantee success, and certain factors need to be considered. Donavant (2009) observed a relationship between online learning success and formal education level. At the public school level, Wallace (2004) noted that many teachers are not sufficiently prepared to integrate the Internet in the classroom. Even at the university program level, the advancement of distance learning is challenged by obstacles (Godschalk, 2001). In addition, student preparedness is a factor that needs to be considered (Kuechler, 1999; Jensen-Lee & Falahey, 2002). Another factor is student willingness to contribute online (Jensen-Lee & Falahey, 2002). Although search engines provide a great deal of functionality, a creative mindset is needed that can expand upon an established structure (Kendrick, 1999). In regards to the incorporation of materials on the Internet, it is beneficial to be aware of copyright limitations (Jensen-Lee & Falahey, 2002; Ludlow, 2003).

Proposed Model

Fort Hays State University provides several GIS courses: Introduction, Intermediate, Advanced GIS, and GIS Programming. Considering the documented positive results of utilizing web-based resources and innovative practices towards improving education, researching their potential to improve GIS education has merit. Therefore, exploring the creation of a web-based pedagogical model to enhance GIS education is the research objective.

The model would have three primary objectives: First, to create a web-based resource containing technical and theoretical GIS information that could be easily accessed and enhanced. Moreover, this resource would be available after graduation and if accessed regularly, potentially improve retention of GIS theoretical knowledge and technical skills. Second, to provide an electronic environment that allows students to interact and solve problems in a collective and efficient manner. Third, to enhance technical spatial problem solving skills, and providing an archive of successful approaches. The model would be divided into three components: resource development, assessment, and engagement/problem solving.

Student Websites

Considering the ease with which individuals can access the Internet, it is logical for a web-based model to incorporate individual websites. With increased access to the Internet via computers and mobile devices, students who develop and maintain their GIS Technical Information website would have access to Just-In-Time knowledge that is essential in the professional community. For preliminary studies, Google was chosen as the provider of personal websites for a variety of

reasons. Aside from being a free service, Google provides a variety of functions that can be integrated into personal websites that make them ideal for use in this manner. These include: the ability to set access, services like Google Maps for geographic inquiry, and an Internet based email system (Google, 2010).

Resource Development

ArcGIS software has many operations available, and often, users become proficient using a certain set of them to accomplish specific tasks. Both necessity and curiosity are catalysts towards exploring the functionality available. Student web-pages would contain several primary folders: data entry, data creation, data editing, attribute analysis, spatial analysis, and output display. For each, students would be tasked with describing how to complete various operations. The range of task complexity would range from introductory in level to advanced. The option to include graphics, animations, and sound files would be available. Entering technical descriptions for GIS tasks would be treated as course assignments and awarded points for completion. A rubric for scoring would be established using performance standards common in the GIS community. Ultimately, the quality of web-based documentation would be based on the pragmatic approach of whether or not students could complete documented GIS technical tasks whenever asked. If the documentation entered was not sufficient in content, students would have the opportunity to augment it in the future.

Beyond online assignments, quizzes and exams would assess student knowledge and proficiency in GIS theory and technical operations documented in their personal GIS websites. This approach provides the means for assessments to engage more technical operations and content versus the more

traditional approach. Student access to personal GIS websites makes it reasonable to expect a higher level of performance in the classroom.

Engagement and Problem Solving

To help improve problem solving skills, the course websites would address a variety of real-world scenarios to be solved using GIS. Some of these could include: natural disaster management, economic analysis, and resource management. Using a chat room, each student would contribute several points of consideration towards solving the problem. Participation points would be awarded based on their level of interaction and constructive ideas shared via a rubric. Aside from in-class discussion, establishing a chat room would allow for discussion and problem solving to continue beyond scheduled class time. The best approaches towards problem solving scenarios would be archived on personal GIS websites for further reference. The creation of flow charts to illustrate problem solving steps could also provide a useful method of visually mapping the required steps.

Preliminary Study

During the Fall of 2009, a preliminary study was conducted at Fort Hays State University in the Intermediate GIS course. Students were asked to develop personal GIS websites for use in the classroom. No statistical analysis was attempted at this preliminary stage; however, a variety of useful observations were made:

Although many traditional students are adept in the use of computers and the Internet, not all students are comfortable with web-site development. Initially students were directed to create a personal GIS websites and set up the appropriate folder

structure. Unfortunately, some who struggled with creating their web-sites were reluctant to ask for help. By the time this was noticed, several students had already fallen behind. The solution was to develop all websites as a class and proceed only after each student demonstrated the ability to add and edit entries.

The level of note taking and documenting technical operations was on occasion, inadequate. With increased access information on the Internet, the practice of note taking seems to be challenged. As with creating websites, instruction on how to logically document technical operations is beneficial.

Due to the nature of GIS, an operation that falls under the category of analysis could also be labeled as data editing. This situation can make it difficult to determine where entries belong on personal web-sites. A simple solution is requiring students to create a reference that identifies the location of each technical description like a book's table of contents.

The unforeseen obstacles towards student creation of personal GIS websites made using them during exams problematic. In order for this approach to be fair for the entire class, the development of these resources must have an adequate amount of structure established prior to implementing this approach. However, several students from this course were enrolled in the Advanced GIS course in the Spring of 2010. It was observed that they referenced their personal GIS websites at various times in class to work through technical tasks addressed in Intermediate GIS.

Summary

Research literature suggests that the utilization of web-based resources can enhance the classroom learning experience for students. There are a variety of approaches that can be taken, but research also indicates that adhering to a

predetermined course of action or model is a significant component towards meeting pedagogical objectives. The development of a Web-based model for GIS education has the potential to improve learning through: student generated documentation, ease of access to technical and problem solving strategies, student collaboration, online assessments, and timely feedback. The preliminary study of student development of personal GIS websites suggests that establishing a structure that addresses the various student levels of familiarity regarding website development is required. Moreover, providing an adequate framework towards managing technical and theoretical documentation entries is beneficial. Implementing and testing the proposed model using a quasi-experimental approach is the next step in this research.

References

- Chappell, D. S., Schermerhorn, J. R. Jr. (1999). Using Electronic Student Portfolios in Management Education: A Stakeholder Perspective. *Journal of Management Education*, 23, 651-662. Doi: 10.1177/105256299902300604
- Cho, W., Schmeizer, C. D., McMahon, P. S. (2002). Preparing Hospitality Managers for the 21st Century: The Merging of Just-in-Time Education, Critical thinking, and Collaborative Learning. *Journal of Hospitality & Tourism Research*, 26, 23-37. Doi: 10.1177/1096348002026001002
- Davis, B. E., (2001). *GIS: A Visual Approach*(2nd. Ed.). New York: Onword Press, Thompson Learning.

- Donavant, B. W. (2009). The New, Modern Practice of Adult Education: Online Instruction in a Continuing Professional Education Setting. *Adult Education Quarterly*, 59, 227-245. Doi: 10.1177/0741713609331546
- Godschalk, D.R., Lacey, L. (2001). Learning at a Distance: Technology Impacts on Planning Education. *Journal of Planning Education and Research*, 20, 476-489. Doi: 10.1177/0739456X0102000411
- Google (2010). <http://www.google.com/>
- Jensen-Lee, C., Falahey, A. (2002). Using the Web: a discussion of some of the non-technical factors to be taken into account when designing web sites intended to support courses taught primarily in face-to-face mode. *Journal of Sociology*, 38, 291-301. Doi: 10.1177/144078302128756679
- Kendrick, T. (2007). The winning midset: Effective competitive intelligence research on the internet . *Business Information Review*, 24, 228-235. Doi: 10.1177/0266382107084890
- Kuechler, M. (1999). Using the Web in the Classroom. *Social Science Computer Review*, 17, 144-161. Retrieved from <http://rsw.sagepub.com/content/17/2/144>
- Longley, P., Batty M. (1996). *Spatial Analysis: Modelling in a GIS Environment*. New York: John Wiley and Sons, Inc.
- Longley, P.A., Goodchild, M.F., Maguire, D.J., Rhind, D.W. (2007). *Geographic Information Systems and Science (2nd Ed.)*. West Sussex, England: John Wiley & Sons, Ltd.

- Ludlow, B.L. (2003). Understanding Copyright and Intellectual Property in the Digital Age: Guidelines for Teacher Educators and their Students. *Teacher Education and Special Education: The Journal of the Teacher Education Division of the Council for Exceptional Children*, 26, 130-144. Doi: 10.1177/088840640302600207
- Obermeyer, J.N., Pinto J.K. (2008). *Managing Geographic Information Systems (2nd Ed.)*. New York: Guilford Press.
- Ormsby, T., Napoleon, E., Burke, R., Groessl, C., Bowden, L. (2009). *Getting To Know ArcGIS Desktop (2nd Ed.)*. Redlands, California: ESRI Press.
- Persell, C. H. (2004). Using Focused Web-Based Discussions to Enhance Student Engagement and Deep Understanding. *Teaching Sociology*, 32, 61-78. Doi: 10.1177/0092055X0403200107
- Schoech, D. (2000). Teaching Over the Internet: Results of One Doctoral Course. *Research on Social Work Practice*, 10, 467-486. Retrieved from <http://rsw.sagepub.com/content/10/4/467>
- Stocks, J. T., Freddolino, P. P. (2000). Enhancing Computer-Mediated Teaching Through Interactivity: The Second Iteration of a World Wide Web-Based Graduate Social Work Course. *Research on Social Work Practice*, 10, 505-518. Retrieved from <http://rsw.sagepub.com/content/10/4/505>
- Vinokur, A. D., Merion, R. M., Couper, M. P., Jones, E. G., Dong, Y. (2006). Educational Web-Based Intervention for High School Students to Increase Knowledge and Promote Attitudes Toward Organ Donation. *Health Education & Behavior*, 33, 773-786. Doi: 10.1177/1090198106288596

- Wade, T., Sommer, S. (Ed.). (2006). *A To Z: An Illustrated Dictionary of Geographic Information Systems*. Redlands, California: ESRI Press.
- Wallace, R.C. (2004). A Framework for Understanding Teaching With the Internet. *American Educational Research Journal*, 41, 447-488. Doi: 10.3102/00028312041002447

Repositioning the Facilities in Technical College Workshops for Efficiency: A Case Study of North Central Nigeria

Ibrahim Y. Umar
Southwest University, Chongqing-China.

Abdullahi S. Ma'aji
Federal University of Technology, Minna-Nigeria

Abstract

This article focuses on assessing the facilities in Government Technical College workshops in the context of a developing country. A descriptive survey design was adopted. Two research questions and a hypothesis were formulated to guide the study. A 35-item questionnaire was developed based on the National Board for Technical Education (NBTE) standards on Technical College workshops, and was validated by three experts. Data was collected from 101 administrators, 140 teachers, and 24 workshop personnel randomly sampled and stratified along trades in 19 Government Technical Colleges in North Central Nigeria. Mean was employed to answer the research questions while one-way analysis of variance (ANOVA) was employed to test the hypothesis using Statistical Package for Social Sciences (SPSS) for analysis. Results revealed that administrators, teachers, and workshop

Ibrahim Y. Umar is a Doctoral Student in the Vocational Education Programme, Southwest University, Chongqing. He can be reached at iyumar36@gmail.com. Abdullahi S. Ma'aji is in the Industrial and Technology Education Department, Federal University of Technology, Minna-Nigeria. He can be reached at drasmaaji@yahoo.com.

personnel shared similar views on inadequacy of facilities in Technical College workshops. It was therefore recommended that: The private sector should be encouraged to initiate and participate in the provision of facilities using such methods as build operate-and-transfer (BOT), build own-operate and transfer (BOOT) and rehabilitate-operate and transfer (ROT); special intervention funds should be set aside by Government for procurement of workshop facilities to technical colleges, such channels may include Education Tax Fund (ETF) as practiced in Nigeria; Non Governmental Organizations (NGOs), Parent Teacher Association (PTA), and Community Based Organizations (CBOs) should be asked for support in supplying relevant facilities to the workshops as obtained in some nations; and that a specific percentage of income tax generated annually by the Government should be utilized for provision of workshop facilities in technical colleges.

Introduction

Technical colleges in Nigeria have been training people to become craftsmen and technicians. Training qualifies them for jobs in both public and private sectors of the economy. Both sectors, according to Ndomi (2005), require well-trained and competent technicians who can operate and maintain the available technical equipment. Therefore, there is a need for qualitative technical colleges for education and training to produce graduates that can perform competently in their chosen vocation without a need for pre-employment training. The major goal of vocational institutions is to prepare students for successful employment in the labor market (Finch & Crunkilton, 1999). This condition can be met through a curriculum that is relevant and comprehensive and a well equipped workshop with relevant training facilities. School workshops offer opportunities for practical training of students

in skill acquisition in their technical trade areas for future development of the key sectors of the economy in order to meet the basic needs of electricity, roads and machinery, among others. Student's practical projects are an important part of the curriculum in technical colleges, but a supportive school environment is a fundamental requirement for the successful implementation of curriculum (Bybee & Loucks-Horsely, 2000; Penney & Fox, 1997). This aspect of the curriculum can only be implemented where facilities in the workshop are adequate and relevant. Availability of appropriate facilities enhances student learning by allowing them to be involved in demonstrations, and practice will continue to build their skills. However most of the technical colleges in Nigeria have been forced to perform below standard due to purported non availability, poor management or utter neglect of the required facilities in the workshops for effective training.

According to Aina (2000), performance at the National Technical Certificate (NTC)/National Business Certificate (NBC) examinations taken in technical colleges in 1999 revealed very disturbing statistics attributable to utter neglect, poor funding, and inadequacy of resources. Poor management of facilities resulted in failure rates from 14 percent - 48 percent in Electrical and Mechanical trades, 12 percent - 50 percent in Construction trades and 18 percent - 94 percent in Business trades. Atsumbe (2002) observed that due to inadequate funding, normal workshop practice, which forms 60 percent [standard set by National Board for Technical Education (NBTE)] of the technical college curriculum, is fast disappearing on vocational/technical colleges' time tables. Ideally in the workshop there is equipment for acquiring skills, consumable materials purchased and distributed for practice; physical facilities arranged and given occupational direction so that acceptable work habits and procedures are successfully executed. Towe (2000) and Asilokun (2004) maintained that

these workshops were originally designed and built for small populations of students. However in recent times the student population, especially in urban schools, has increased tremendously, thereby over-stressing the available space and facilities. To worsen the situation, Puyate (2002) maintained that the present state of vocational education facilities is very poor, there is no planned means of maintenance of the already broken down equipment or means of purchasing new ones, there is little or no concern on the part of government, teachers and students for the improvement of the present state of facilities. This pathetic situation needs to be reverted in order to meet the goals of technical and vocational education as enshrined in the National Policy on Education of Nigeria (Federal Government of Nigeria, 2004). According to the policy, the goals shall be to provide trained manpower in the applied sciences, technology and business particularly at craft (equivalent of high schools), advanced craft and technical levels; provide the technical knowledge and vocational skills necessary for agricultural, commercial and economic development; to give training and impart the necessary skills to individuals who shall be self reliant economically.

At all levels of the nation's educational system and for all known and existing school types, instructional resources or teaching and learning materials are an indispensable factor in the attainment of goals (Mkpa, 2001). The study conducted by Onyejemezi (2001) on quality, quantity, production and distribution of teaching resources/facilities revealed that tertiary institutions are hardly supported with educational resources, even in the face of 'Accreditation fever'. Resource support from foreign countries is no longer available to Nigeria schools. Although modern teaching materials such as computers, flip charts, projectors, videos, etc. are to be found in the educational system, their distribution varies from school to school (Nnoli, 2001, p. 199). The extent of the deterioration

of educational structures such as physical plants, infrastructures and facilities, where these educational structures are available, is amazing. In many schools, the non-availability of these facilities is more striking than their condition (Nnoli, 2001, p. 207).

Given the scenario above, the situation at technical colleges might not be different. The researchers therefore took up the task to assess technical college workshops in North Central Nigeria in order to ascertain the state of affairs and meeting the goals of technical and vocational education which are synonymous to society needs. The intention was to provide feedback on the position of facilities meeting the policy objectives to educational planners and policy makers, particularly the National Board for Technical Education (NBTE). The study sought an answer to each of the following research questions and tested the null hypothesis that follow at 0.05 level of significance.

1. How adequate are the facilities in technical college workshops?
2. What are the strategies toward acquiring adequate facilities in technical college workshops?

Ho₁: There is no significant difference between the mean responses of the administrators, teachers and workshop personnel with respect to their perceptions on the adequacy of facilities in technical college workshops.

Methodology

A descriptive survey research design was adopted in this study. In a typical survey, the researcher selects a sample of respondents and administers a standardized questionnaire to them (Babbie, 1998). The study covered all Government

Technical Colleges located in the three states of Benue, Kwara, Niger, and the Federal capital territory-Abuja, all of which are in North Central Nigeria. A stratified random sampling technique was used in order to involve a variety of proportional participants in the management of technical college workshops. Stratified random sampling divides populations into strata, and then randomly selects samples from each stratum (Neill, 2006). There were three strata in the sample with 101-Administrators (Principals, Vice Principals & Heads of department), 140-Teachers, and 24-Workshop personnel (workshop Assistants & Attendants) represented. Therefore, the sample for the study comprised of 265-subjects from the clusters of engineering and construction trade programs in 19 Government Technical Colleges in the area of the study (NBTE, 2001).

A 35-item structured questionnaire was used for data collection. It was developed based on the existing NBTE standards on technical college workshops and literatures on the subject matter. Two different response categories were used based on a four point rating scale, they are: Very adequate (4); adequate (3); Inadequate (2); Very inadequate (1); used in research question one, and strongly agree (4); Agree (3); Disagree (2); strongly disagree (1); used in research question two. The instrument was subjected to face validation by three experts, comprising of a staff member from NBTE, a principal and a lecturer from the department of Industrial and Technology Education, Federal University of Technology, Minna. Their suggestions were used to refine the questionnaire to its present form. A pilot testing of the instrument was carried out with forty respondents selected from the three strata in two states not involved in the study. A Cronbach's alpha was used to measure the reliability of the instrument. The reliability co-efficient value of 0.80 allowed the researchers to launch the study on a large scale (Gay, 2002). The instrument was administered to the respondents by the researchers and the

research assistants. Data collected was analyzed using the Statistical Package for Social Sciences (SPSS), mean for answering the research questions and one way analysis of variance (ANOVA) for testing of hypothesis. Items with mean values of 2.50 and above were considered adequate/agreed while items with mean values of 2.49 and below were considered inadequate/disagreed. The hypothesis was accepted for f-ratio (calculated) less than f-ratio (table value), otherwise, it was rejected.

Results

The results of the data analysis are presented in the order of the research questions and hypothesis as follows:

Research Question One

How adequate are the facilities in Technical College workshops?

To answer this research question, facilities required in the workshops based on NBTE standards were presented to administrators, teachers and workshop personnel to indicate their adequacies; their responses are as presented in Table 1.

Table 1

Respondents mean scores on the adequacy of facilities in the Technical College Workshops.

$n_1 = 101$, $n_2 = 140$, $n_3 = 24$

S/ No	ITEM	M_1	M_2	M_3	M_t
1	Workshops for 20 students in trade areas	2.9 3	2.9 6	2.9 6	2.95
2	Electricity from national grid	2.5 5	2.6 9	2.5 4	2.59

3	A classroom or improvised space for teaching of 30 students	2.9 1	2.8 1	2.7 5	2.82
4	Library facilities for 1/3 of its readers	2.2 5	2.2 1	2.2 9	2.25
5	Office space for 2 staff located in the workshop	2.5 1	2.5 6	2.6 3	2.57
6	Location of at least one lavatories at one end of the workshop	2.0 7	1.8 8	2.1 7	2.04
7	Space (2.4m by 1.2m) for exhibits in the workshop	2.3 1	2.3 1	2.2 9	2.30
8	Space for planning and drawing for at least 10 students	2.2 3	2.3 8	2.3 3	2.31
9	Floor space available per student in activity areas for 20 students	2.5 0	2.5 4	2.5 4	2.53
10	Locker space for 20 students	2.2 1	2.2 6	2.1 7	2.21
11	A store with racks and boxes for storage of tools	2.3 2	2.3 2	2.4 2	2.35
12	Two quantities of first aid facilities	2.0 5	1.9 7	2.1 7	2.06
13	4 cylinders of fire extinguishers	1.8 8	1.9 9	2.3 8	2.08
14	16 quantities of standard work benches	2.5 0	2.4 5	2.2 9	2.41
15	Platforms (2.4m by 1.2m) for materials and finished projects	2.0 3	2.2 4	2.2 1	2.16
16	Standard outside entrance doors with double openings	2.6 4	2.7 6	2.7 9	2.73
17	Sizes and location of	3.0	2.8	2.8	2.93

	windows	3	9	8	
18	15 quantities of discharge lamps for artificial lighting	2.6	2.5	2.4	2.54
19	Special drive ways leading to doors providing access for deliveries.	2.5	2.4	2.2	2.37
		0	1	1	
20	One accessible bulletin board	2.1	2.2	2.1	2.20
		9	9	3	
21	Service connections and 15 units of electrical outlets.	2.3	2.5	2.0	2.31
		7	7	0	
22	A single pipe line gas outlet facilities.	1.8	1.1	2.0	1.67
		1	7	4	
23	Ceiling fans or A/Cs for ventilating systems in the workshop.	2.5	2.5	2.5	2.53
		1	1	8	

Key: M_1 = Mean Responses of Administrators,
 M_2 = Mean Responses of Teachers
 M_3 = Mean Responses of Workshop Personnel,
 M_t = Mean Responses of all Respondents
 n_1, n_2 & n_3 = Number of Administrators, Teachers
and Workshop Personnel respectively.

The mean responses of administrators, teachers and workshop personnel as shown in Table 1 indicated that out of 23 items, only 9 items, i.e. items 1, 2, 3, 5, 9, 16, 17, 18 and 23 were identified as adequate based on the criterion mean of 2.50. This indicated that only 39% of facilities are adequate, 61% are inadequate. Though there were no divergent opinions on the items mentioned above, individual respondents differed on items 19 and 21 where administrators agreed on the adequacy of item 19 while others disagreed. Likewise, teachers agreed on the adequacy of item 21 while administrators and workshop personnel on one side disagreed.

Research Question Two

What are the strategies toward acquiring adequate facilities in Technical College workshops?

To answer this research question, statements relating to strategies toward acquiring adequate facilities in technical college workshops were stated in the instrument based on the literatures. The data for the analysis based on the responses of administrators, teachers, and workshop personnel is presented in Table 2.

Table 2

Respondents mean scores on the strategies toward acquiring adequate facilities in Technical College workshops.

$n_1 = 101, n_2 = 140, n_3 = 24$

S/ No	ITEM	M_1	M_2	M_3	M_t
24	Private sector should be encouraged to initiate and participate in provision of facilities.	3.3 4	3.4 4	3.4 2	3.40
25	Linkages between schools and private sector should be strengthened.	3.4 7	3.5 2	3.6 7	3.55
26	There should be alliance between schools and interest groups.	3.5 6	3.3 9	3.3 8	3.44
27	Industries should be sought through cooperation to assist schools.	2.9 8	2.7 5	2.9 6	2.90
28	Government should solicit support from NGOs and PTAs for assistance.	3.4 5	3.3 6	3.2 9	3.37
29	Community based organizations (CBOs) should	3.1 0	2.5 6	2.4 4	2.70

be sought for help.

30	10% of Education Tax Fund (ETF) should be used for procurement of workshop facilities.	3.5 0	3.3 6	3.5 4	3.47
31	5% of money realized from value added tax (VAT) should be utilized for workshop facilities.	3.6 7	3.2 9	3.3 9	3.45
32	Principals should embark on protest writing to concerned authorities.	2.4 5	2.4 0	2.5 4	2.46
33	Workshop should be used profitably for private jobs during weekends and public holidays.	2.8 3	2.8 4	3.0 0	2.89
34	Improvisation should be embarked upon by the school authorities.	2.1 0	2.8 4	3.3 6	2.77
35	Parents should be taxed annually and money realized use to provide facilities to workshops.	2.1 6	2.3 5	2.4 6	2.32

The analysis on Table 2 reveals that ten items were agreed upon as relevant strategies toward acquiring adequate facilities in technical college workshops with mean of items ranging from 2.70 to 3.55. Items 32 and 35; however, disagreed with mean score of 2.46 and 2.32 respectively. The analysis revealed that 83% of the items suggested as strategies toward acquiring adequate facilities were seen by respondents as relevant, while 17% of the items were irrelevant. In items 29 and 34 there were divergent views among the respondents.

Administrators, for example, disagreed with the statement; improvisation should be embarked upon by school authorities as strategy, while teachers and workshop personnel see it as a relevant strategy.

Hypothesis

H₀₁: There is no significant difference between the mean responses of administrators, teachers and workshop personnel with respect to their perceptions on the adequacy of facilities in technical college workshops.

This hypothesis was tested and the result, as presented in Table 3 shows that there is no significant difference ($p < 0.05$) in the mean responses of administrators, teachers and workshop personnel on the adequacy of facilities in technical college workshops. Thus, the null hypothesis was accepted at .05 level of significance.

Table 3
One way Analysis of Variance (ANOVA) of Respondents Perception on the Adequacy of Facilities in Technical College Workshops.

Sources of Variation	df	Sum of Squares	Mean Squares	F-cal	Critical Value of F
Between groups	2	0.0002	0.0001	0.0037	3.00
Within groups	262	7.0200	0.0268		
Total	264	7.0202			

Note: $p < 0.05$, $N = 265$

Discussion of Findings

The findings indicated that majority of the technical college workshops did not have adequate facilities. Table 1 revealed that library facilities, location of lavatories at one end of the workshop, locker space for each student, racks and boxes for storage of tools, first aid facilities and standard work benches were inadequate. This is in line with the work of Abdullahi (2003) that every training school faces the problem of providing and maintaining suitable workshop and appropriate facilities for technical and vocational training programs. These findings were also supported by Moja (2000) that the problems of Technical and Vocational Education (TVE) in Nigeria are made worse by the poor condition/inadequacy of training facilities. Adequate workshop facilities are necessary for any quality learning to take place. Facilities aid the instructors to communicate more effectively and the learners to learn more interestingly, meaningfully and permanently.

Inadequate supply of standard work benches, first aid facilities and other teaching aids meant to enhance greater understanding and appreciation of the learning experiences as revealed in Table 1 is likely to have a negative effect on skill acquisition by students passing through the program. Anyakoha (1992) in support of the findings noted that the development of useful skills can be reinforced by the appropriate selection and use of learning facilities and resources. These facilities comprises of workshop structures, working materials, teaching materials, workshop tools and equipment. In the same vein Uzoagulu (1992), warned that where equipment and tools are not functional or adequately provided, technical training programs will suffer and will lead to the production of highly unskilled personnel who are unemployable and unproductive. Therefore, inadequate

workshop facilities in technical college programs deterred skill acquisition. Only a few workshop facilities in the technical colleges are adequate according to the findings.

The analysis on Table 3 shows that null hypothesis was not rejected. This means that there is serious shortage of facilities in technical college workshops with the three categories of respondents attesting to it. This confirms the study conducted by Aina (1999) that some colleges lack not only workshops and laboratories, but also where such are provided; they are ill-equipped and lack the basic tools and equipment for instruction. This implies that facilities need to be provided in the technical college workshops for efficient response to society needs.

With reference to strategies toward acquiring adequate facilities in technical college workshops, findings on Table 2 revealed that the private sector should be encouraged to initiate and participate in the provision of facilities, linkages between schools and the private sector should be strengthened and that there should be alliance between schools and interest groups. This result is in consonance with observation made by Yakubu (2005) that financing of institutions in Nigeria is becoming prohibitive and a heavy burden for government to bear alone. Yakubu urged proprietors to explore other sources of funds to enable them to generate enough to adequately equip institutions for effective teaching and learning. Edache (2001) stressed the need for diversifying the sources of financing technical education and advised that foreign assistances should be sought by the federal, state and local governments where possible for rehabilitation of technical workshops in our schools. On the international perspective, various mechanisms to fund vocational education and training in South Africa are being developed, including the Medium Term Expenditure Frameworks (MTEFs), special purpose funding, program based funding and public-private partnership funding (Bester, 2004).

Some of these strategies are in line with findings of this study. Industries are supposed to be partners in progress to technical colleges as products from such institutions are employed by it, the findings shows that industries should be sought through cooperation to assist schools. This is very important because by so doing products (students) are fully prepared to take appointment in the industry. Emphasizing the same point, although using a university as a case study, Gore and Leonard (2007) maintained that training tomorrow's leaders requires a collaborative effort between industry and the university. Higher education must build collaborative partnerships, improve all forms of scholarship and provide opportunities for students to contribute to the common good (Boyer, 1990).

This study also revealed that government should solicit support from Non Government Organizations (NGOs), Parent Teacher Association (PTA) and Community Based Organizations (CBOs) for assistance. This strategy for acquiring adequate facilities is in agreement with the works of Prew (2009); Umar, Audu and Idris (2009). The study conducted in South Africa by Prew (2009) revealed that the community should be involved in determining the development priorities in the school, supplying voluntary and paid services to the school, help the school raise and manage funds and sitting on and running some committees. In the same vein Umar et al. (2009) suggested that Non Government Organizations (NGOs), Community Based Organizations (CBOs) and Parent Teacher Associations (PTA) should be made to play a vibrant role in moving technical education forward. Farauta (1999) identified the projects undertaken by the Parent Teachers Association to include the provision of generating plants, laboratory equipment and water tanks. In his study, Uzokwe (2000) concluded that parents should try to give government moral and financial support toward technical

education programs to enable it to achieve its aims and objectives.

Respondents for this study attached great importance to the statement that ten percent of Education Tax Fund (ETF) should be used for the procurement of workshop facilities, five percent of Value Added Tax (VAT) should be utilized for workshop facilities and that workshops should be used profitably for private jobs during weekends and public holidays. This confirms the work of Abdullahi (1998), Bajah (2001) and Umar (2005). Abdullahi (1998) observed that where school workshops and laboratories are used profitably during evenings, weekends and public holidays, the skills of students are upgraded and the financial crunch of technical institutions is combated. Stressing the role of ETF in education Bajah (2001) averred that the ETF's real goal should be to support educational dogmas that will produce technically skilled, empowered generation of women and men for the 21st century. The objective of ETF is to identify areas of weaknesses in the educational sector and intervene with funding to enhance educational facilities and infrastructure development, and promote creative and innovative approaches to educational learning services, among others (Charles & Iheme, 2002). Writing on the funding of vocational centers and technical colleges in a democracy, Umar (2005) stressed that funds realized from VAT should be used for financing of vocational and technical colleges. Unless the shortages of facilities in technical college workshops are addressed by all or some of these strategies, the goals of technical and vocational education are under threat of not being realized.

Conclusion

The desire to produce competent graduates of technical colleges can be achieved when the facilities in the workshops are relevant and adequate for the programs as demanded by the curriculum. This study has shown that facilities in technical college workshops are inadequate and identified some relevant strategies toward acquiring adequate facilities in technical college workshops. Hence, the call for immediate implementation of these strategies in order to meet the goals of technical and vocational education as usually identified in the National Policy on Education of every Nation.

Recommendations

Based on the above revelations from the findings of this study, the following recommendations are necessary in order to reposition the facilities in technical college workshops for efficiency:

- The private sector should be encouraged to initiate and participate in the provision of facilities, using such methods as build operate-and-transfer (BOT), build own-operate and transfer (BOOT), and rehabilitate-operate-and-transfer (ROT).
- Linkages between schools and the private sector should be strengthened to ensure the appropriate interface with the world of work. This could be achieved through constant invitation of private sectors to participate in school programs leading to proper understanding and integration.
- Industries should be sought as partners in progress to assist in provision of facilities. This could be achieved through interactions as technical colleges

provide industry with a pool of potential employees.

- Non Governmental Organizations (NGOs), Parent Teacher Association (PTA), and Community Based Organizations (CBOs) should be sought for support in supplying relevant facilities to workshops as obtained in some nations.
- Special intervention funds should be set aside by government for procurement of workshop facilities to technical colleges, such channels may include Education Tax Fund (ETF) as practiced in Nigeria.
- A specific percentage of Income tax generated annually by Government should be utilized for the provision of workshop facilities to technical colleges.
- Government should provide adequate facilities to technical college workshops using current strategies identified to ensure acquisition of relevant skills, and knowledge and experience that are relevant to the growth of the country.

References

- Abdullahi, S. M. (1998). Innovative Approaches for Funding Technology Education Programs in Nigeria Schools. In A. W. Ajetunmobi, T. A. G. Oladimeji & K. A. Salami (Eds), *Technology Education and the Realization of vision 2010*. Annual NATT conference-Minna. 14th – 17th October.
- Abdullahi, S. M. (2003). Evaluation of Vocational Technical Training Programs in Northern Nigeria Prisons. *Journal of League of Researchers in Nigeria (JOLORN)*. 8 (1), 146-153.
- Aina, O. (1999). Technical Education in Nigeria – A Bridge to the future, fifth National Biennial Convention of the Auchi Polytechnic. 4th-7th October.
- Aina, O. (2000). Technical and Vocational Education in Nigeria: Vision and action; Blue print and master plan – Federal Ministry of Education (2001 – 2010).
- Anyakoha, E. U. (1992). Development and utilization of facilities for home economic education program in Nigerian schools and colleges for manpower development, *Nigerian Vocational Journal* 2(1), 16 – 24.
- Asilokun, B. A. (2004). Development and Managing Schools Workshop towards achieving Sustainable NEEDS. In G. N. Nneji, M. A. Ogunyemi, F. O. N. Onyeukwu, M. Ukponson, S. O. Agbato, E. A. Nnenji (Eds.), *Technology Education as an impetus for sustainable NEEDS*. 17th Annual NATT conference – Abuja. 94 – 97.
- Atsumbe, B. N. (2002). Mechanisms for Improving Manpower Production in Vocational and Technical Education. *Akoka Journal of Education*. 1 (2) 165 – 178

- Babbie, E. (1998). *The Practice of Social Research 8th Edition*. Belmont, C A: Wadsworth Publishing Company.
- Bajah, S. T. (2001). Stakeholders at Home and Abroad. In O. Nnoli & I. Sulaiman (Eds). *Reassessing the Future of Education in Nigeria*. Abuja: ETF Publication.
- Bester, G. (2004). Further Education and Training in South Africa. In L. Moran & G. Rumble (Eds). *Vocational Education and Training through Open and Distance Learning. Volume 5*. London: RoutledgeFalmer.
- Boyer, E. (1990). *Scholarship Reconsidered: Priorities of the Professoriate, the Carnegie Foundation for the Advancement of Teaching*. New Jersey: Princeton University Press.
- Bybee, R & Loucks-Horsely, S. (2000). Standard as Catalyst for Change in Technology Education. *The Technology Teacher*, 59 (5), 14-17.
- Charles, H. J., & Iheme, E. (2002). *Nigeria Private Sector and Education for all: A Report on the Private Sector Round Table*. Ibadan: Spectrum Books Ltd.
- Edache, E. (2001). Sources of Revenue for Technical Institutions in Nigeria. A Paper Presented at the National Conference organized by COEASU FCE Pankshin on 2nd -5TH May.
- Farauta, K. G. (1999). A Survey of the Role of Parent Teachers Association in the Effective Implementation of Pre-vocational Courses Post Primary institutions of Numan Metropolis, Adamawa State. *Sabondale Journal of Technical Education*, 2(1), 31- 34.
- Federal Government of Nigeria. (2004). *National policy on education 4th edition*. Lagos: NERDC press.

- Finch, C. R. & Crunkilton, J. R. (1999). *Curriculum Development in Vocational and Technical Education: Planning, Content and Implementation*, 5th Edition. Boston: Allyn and Bacon.
- Gay, L. R. (2002). *Educational Research Competencies for Analysis and Application*. Lahore: Combine Printers (PVT) Ltd.
- Gore, D. W., & Leonard, J. (2007). Industry and University Collaboration for Training tomorrow's Leader. In *the past, the present, the future*. 40th Annual Convention of National Association of Industrial Technology (NAIT). Held from 23rd – 27th October, at Panama City beach, Florida. Retrieved June 6th, 2009 from <http://scholar.lib.vt.edu/ejournals/jte>.
- Mkpa, A. M. (2001). Optimization of Available Teaching and Learning Materials/Facilities. In O. Nnoli & I. Sulaiman (Eds). *Reassessing the Future of Education in Nigeria*. Abuja: ETF Publication.
- Moja, T. (2000). Nigeria education sector analysis: An analytical synthesis of performance and issues. Document produced for the World Bank.
- NBTE. (2001). *Digest of Statistics on Technical Colleges in Nigeria*. Kaduna: NBTE Publication Unit.
- Ndomi, B. M. (2005). Revisiting the Learning Experience of Technical College Farm Machinery Curriculum for Empowerment of Recipients in Nigeria. *Journal of Nigerian Association of Teachers of Technology (JONATT)*. 5 (1) 88 - 94.
- Neill, J. (2006). Analysis of Professional Literature. Retrieved October, 10th 2009 from <http://wilderdom.com/OEcourses/PROFIT/class6qualitative1.htm>.

- Nnoli, O. (2001). Prospect for the Future of Education in Nigeria. In O. Nnoli & I. Sulaiman (Eds). *Reassessing the Future of Education in Nigeria*. Abuja: ETF Publication.
- Onyejemezi, D. A. (2001). Quantity, Quality, Production and Distribution of Teaching Resources/Facilities. In O. Nnoli & I. Sulaiman (Eds). *Reassessing the Future of Education in Nigeria*. Abuja: ETF Publication.
- Penny, D. & Fox, B. (1997). ‘At the Wheel or Back Seat Dinners?: The Role of Teachers in Contemporary Curriculum Reform. *Queens land Journal of Educational Research*, 13 (2), 14–27.
- Prew, M. (2009). Community Involvement in School Development: Modifying School Improvement Concept to the needs of South African Township Schools. *Journal of Educational Management, Administration and Leadership*. 37 (6) 824 - 846. Retrieved October 23rd, 2009 from <http://ema.sagepub.com>.
- Puyate, S. T. (2002). Survey of Vocational Education Facilities in Government Technical Colleges in Rivers State. *Journal of Nigerian Association of Teachers of Technology (JONATT)*.4(1), 175 – 181.
- Towe, P. E. O. (2000). An In-depth review and assessment of the present state and focus of Technical and Vocational Education in Nigeria. A paper presented at National Seminar on TVE in Nigeria; Vision and Action 31st October – 2nd November. National Center for Women Development, Abuja.
- Umar, I. Y. (2005). Mechanism for Improving the Funding of Vocational Centers and Technical Colleges in a Democracy. *Journal of Nigerian Association of Teachers of Technology (JONATT)*. 5 (1) 113 – 118.

- Umar, I. Y., Audu, R. & Idris, A. M. (2009). Public Private Sector Participation in Education: A Panacea for Provision of facilities in Technical Colleges in Nigeria. *Journal of League of Researchers in Nigeria (JOLORN)*. 10 (1) 27 – 32.
- Uzoagulu, A. E. (1992). Towards an Effective Equipment Management (EEM) in Schools for Economic and Technological Self-reliance. A paper presented at the 7th annual conference of the NVA held at FCE (T), Umuze. November 25th – 28th.
- Uzokwe, B. (2000). *Vocational and Technical Education in Nigeria: Problems and Prospects Crisis in Accomplishing Educational Objectives in Nigeria*. Jos: WAIS printing Press.
- Yakubu, N. A. (2005). A Goodwill Message Presented at the National Workshop on Revamping Technical Education in Nigeria organized for Teachers of Technical Colleges and C. O. E. (Tech) by ETF at Chelsea Hotel Abuja. June 22nd – 23rd.

Information for Authors

The *Journal of sTEm Teacher Education* is published three times annually by the Association for sTEm Teacher Education. The *Journal*, formerly the *Journal of Industrial Teacher Education*, was first published in 1963 and is one of the most respected refereed journals in the profession. Past copies of the *Journal* can be accessed at: <http://scholar.lib.vt.edu/ejournals/JITE/>.

The *Journal's* refereed articles can be in one of three categories: 1) research-based manuscripts, 2) conceptual pieces, and 3) dissertation-based manuscripts. Additionally “At Issue” essays, “Comments,” and “Under Review” (reviews of books and media) are published. All published work focuses on science, engineering, technology, and mathematics (STEM) teacher education, with a dedicated emphasis on the T&E of STEM.

Submission Requirements

All manuscripts submitted for publication must be accompanied by a cover letter that specifies the section of the *Journal* for which the manuscript is intended and an abstract that describes the essence of the manuscript in 150 words or less. Manuscripts must conform the guidelines provided in the *Publication Manual of the American Psychological Association*. Use APA’s “place table here” in the text for tables and figures, and place them at the end of the manuscript. Manuscripts should be submitted in electronic form as email attachments or as files on a CD/ disk.

Submission Address

Dr. Robert T. Howell, Editor
Technology Studies Department
Fort Hays State University
600 Park Street
Hays, KS 67601
Telephone: (785) 628-4306
Email: bhowell@fhsu.edu

Manuscripts that do not meet submission requirements will be returned outright to the author. Manuscripts must be the original work of the author(s) and not have been published, be awaiting publication, or under publication considering by another source. Authors must be current members of the Association for sTEm Teacher Education. (Membership details attached.)

**Change of Address and
Undelivered Issues of the *Journal***

AsTEmTE members should forward any changes in their mailing address and report undelivered copies of *JSTE* to:

Emily McKinley
2129 Cumulus Ct.
West Lafayette, IN 47906

AsTEmTE members should encourage libraries and reading rooms at their institutions to subscribe to *JSTE* so that a permanent file of this publication is maintained. Three-year subscriptions to the *Journal* are available to institutions. Institutional subscription inquiries, changes of address, or problems with delivery should be directed to:

Emily McKinley
2129 Cumulus Ct.
West Lafayette, IN 47906

Undelivered copies of *JSTE* resulting from unreported changes of address will not be replaced without charge.

Request for Back Issues of the *Journal*

Back issues of the *Journal of sTEm Teacher Education* (JSTE) are available on a limited basis. Please specify the year(s), volume(s), and issue(s) of the specific journal(s) when ordering. Also indicate the quantity desired. The cost for a back issue of the *Journal* is \$14.00 (United States and Canada) and \$17.50 (foreign). There is no charge for shipping.

Order Form

Name _____

Address _____

City _____ State/Province _____ Zip Code _____

Please send, if available, the following back issues of the *Journal of sTEm Teacher Education*.

<i>Year</i>	<i>Volume</i>	<i>Issue</i>	<i>Quantity</i>
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Total Enclosed: \$ _____

Make check payable to AsTEmTE, in U.S. dollars only. Mail this form and remittance to:

Emily McKinley
2129 Cumulus Ct.
West Lafayette, IN 47906

Membership Rates and Periods

The fee for regular yearly membership in AsTEmTE is \$50 for U.S. and \$60 for international. Student membership is \$15 per year. Student membership applications must contain signatures of the department chair from the student's institution. The membership year runs from January 1st through December 31st. To receive services listed for a full membership year, membership applications must be received by March 5. All membership applications received after September 1st will cause membership services to begin on the following January 1st.

Membership Application and Renewal		<i>Membership</i>
<u>Position</u>	<u>Classification</u>	<u>Type</u>
<input type="radio"/> College administrator	<input type="radio"/> Technology Ed.	<input type="radio"/> U. S. (\$50)
<input type="radio"/> Teacher educator	<input type="radio"/> Trade & industrial	<input type="radio"/> Foreign (\$60)
<input type="radio"/> Secondary/elementary	<input type="radio"/> education	<input type="radio"/> Student (\$15)
<input type="radio"/> school administrator	<input type="radio"/> Technical education	<input type="radio"/> Institutional
<input type="radio"/> Federal or state	<input type="radio"/> Industrial and	<input type="radio"/> (\$150) (not Library)
<input type="radio"/> government employee	<input type="radio"/> military training	<u>Status</u>
<input type="radio"/> Industrial trainer	<input type="radio"/> Other _____	<input type="radio"/> New member
<input type="radio"/> Military trainer		<input type="radio"/> Renewal

Signature of Department Chair* _____

Name _____

Employer _____

Address _____

City _____ State/Province _____ Zip Code _____

*Required for student membership only

Make check payable to AsTEmTE. Mail form and remittance to:

Emily McKinley

2129 Cumulus Ct.

West Lafayette, IN 47906

JITE Editors 1963 – Present

<u>Editor</u>	<u>Volume(s)</u>	<u>Dates</u>
Ralph C. Bohn	1	1963-1964
Robert W. Worthington	2, 3	1964-1966
Carl J. Schaefer	4, 5	1966-1968
Jerome Moss, Jr.	6, 7	1968-1970
David C. Bjorkquist	8, 9	1970-1972
David C. Bjorkquist & H. C. Kasanas	10	1972-1973
H. C. Kasanas	11	1973-1974
Ronald W. Stadt	12, 13	1974-1976
Richard C. Erickson	14, 15	1976-1978
Richard A. Swanson	16, 17	1978-1980
Roger W. Haskell	18, 19	1980-1982
Patrick A. O'Reilly	20, 21	1982-1984
David L. Passmore	22, 23	1984-1986
Patrick W. Miller	24, 25	1986-1988
Thomas J. Walker	26, 27	1988-1990
Dennis R. Herschbach	28, 29	1990-1992
Frank C. Pratzner	30, 31	1992-1994
Scott C. Johnson	32, 33	1994-1996
Rodney L. Custer	34, 35	1996-1998
Karen F. Zuga	36, 37	1998-2000
Marie C. Hoepfl	38, 39	2000-2002
George E. Rogers	40, 41	2002-2004
Janet Z. Burns	42, 43	2004-2006
Richard A. Walter	44, 45	2006-2008
Robert T. Howell	46, 47	2009-2011

Association for sTEm Teacher Education

P.O. Box 2089, West Lafayette, IN 47996

Association Officers:

President:	George Rogers, Purdue University
President-Elect:	Jim Gregson, University of Idaho
Secretary:	Robert Clark, Penn State University
Treasurer:	Mat Sutton, Purdue University
Trustee:	Dennis Herschbach, University of Maryland
Trustee (Past-President):	Mary Jo Self, Oklahoma State University

Association Manager: Emily McKinley

Journal of sTEm Teacher Education Editorial Board:

Editor:	Robert Howell, Fort Hays State University
Associate Editor:	Vacant
Assistant Editors:	Kara Harris, Indiana State University Mark Threeton, Penn State University Paul Asunda, University of Southern Illinois, Dominic Fazarro, The University of Texas-Tyler

Institutional Members

Ball State University
Manatee County Schools, Bradenton, Florida
Purdue University
University of Southern Mississippi
Temple University
Red River College – Winnipeg, Canada
Indiana State University – Terre Haute, Indiana